August 19, 1957 50 Cents

AVIATION WEEK

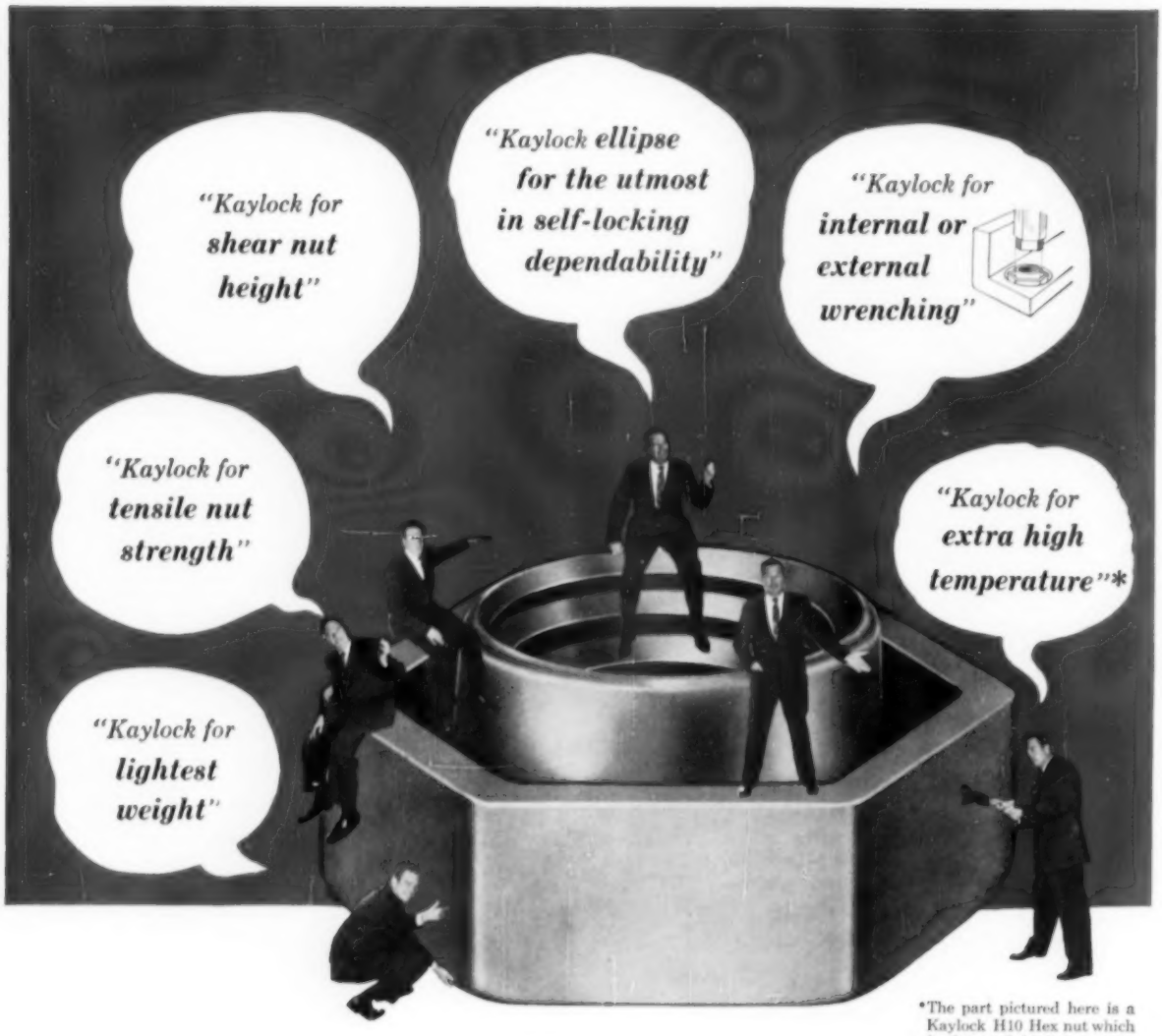
A McGRAW-HILL PUBLICATION

Field Use Stressed In Mach 2 Trident

•

Maser Growing in Avionic Importance

Pratt & Whitney J75, J57


"Kaylock for shear nut height"
"Kaylock ellipse for the utmost in self-locking dependability"
"Kaylock for internal or external wrenching"
"Kaylock for tensile nut strength"
"Kaylock for extra high temperature"*
"Kaylock for lightest weight"

*The part pictured here is a Kaylock H10 Hex nut which is also available in corrosion resistant steel.

KAYLOCK® **has become the Symbol of Leadership–**

All-metal self-locking nuts

based not only on past performance, but on advanced development that provides tomorrow's parts today.

APPROVED FOR ALL
Recognized Aviation Standards

This One Kaylock Hex Nut meets the requirements of the New National Aircraft Standards: NAS 679 Low Height Nut, NAS 1021 Regular Height Nut, NAS 1022 Shear Nut; also approved for all three Air Force-Navy Standards: AN 363 High Temperature Nut, AN 364 Shear Nut, AN 365 Standard Hex Nut.

For more information, write for our catalog.

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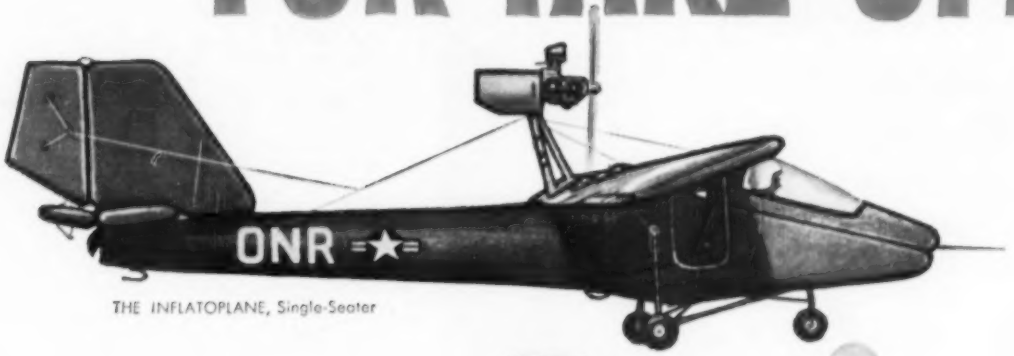
CLEARED FOR TAKE-OFF!

"THE GIZMO"
1-Man Helicopter



THE INFLATOPLANE, Single-Seater

3 examples of AIRBORNE WIZARDRY

with important roles ahead

THE INFLATOPLANE, Two-Place Version

Talk about ingenuity in action—here are two planes that unroll like rugs, fly away like magic carpets! And a helicopter weighing less than 300 pounds that brings reality to what have heretofore been flights of fancy.

These are common-sense developments of Goodyear Aircraft Corporation—born of plenty of imagination and sharp inventive skills—examples of unusual aircraft designed by Goodyear Aircraft to meet military requirements, such as courier liaison, observation, command or any of several others in a given tactical situation.

Whether it be in the production of rockets, electronic guidance, structural plastics, radar structure or complete aircraft—the *imaginative engineering of Goodyear Aircraft rewards those who enlist its skills and facilities.* Goodyear Aircraft Corporation, Akron 15, Ohio.

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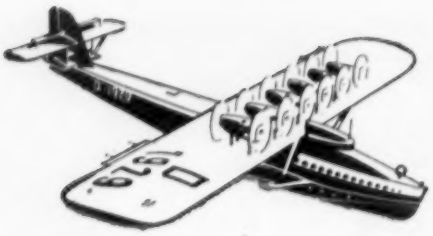

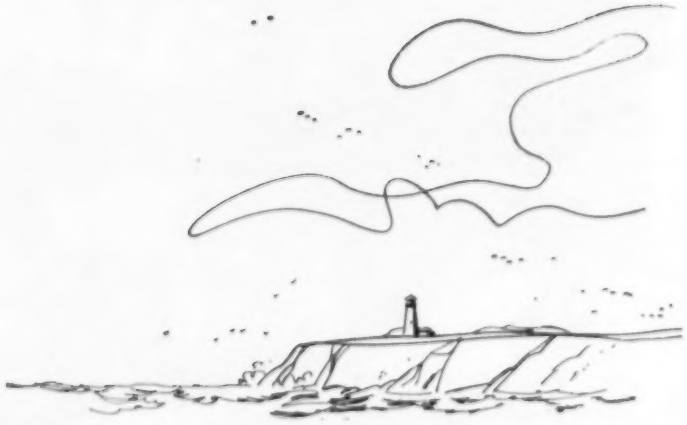

Another famous plane

PROVEN IN SERVICE

1931

DO-X, world's largest flying boat with wing span of 157 feet, features 12 engines which gave it cruising speed of 130 mph.

For reproductions of these advertisements showing airplanes of yesterday together with detailed information of the latest Rockbestos aviation wire, write us and ask for the "Famous Planes" series.

Today the famous Dornier DO-X is a fond memory of the "good old days" of aviation. But even in 1931, over a quarter of a century ago, Rockbestos wire and cable had earned a proven-in-service reputation.

Today, Rockbestos can look back on 39 years of developing and manufacturing quality wire and cable, and a long history of close association with the aviation industry.

Rockbestos has continually produced high temperature wire which meets the exacting standards of modern airplanes . . . both military and commercial.

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AVIATION CALENDAR

Aug. 19-21—Cryogenic Engineering Conference, Boulder (Colo.) Laboratories, National Bureau of Standards.

Aug. 20-22—Bendix-Scintilla International Ignition Conference, Sidney, N. Y.

Aug. 20-23—Western Electronic Show & Convention, Cow Palace, San Francisco, Calif.

Aug. 26-28—Gas Dynamics Symposium, Transport Properties in Gases at High Temperatures and Pressures, Technological Institute, Northwestern University, Evanston, Ill.

Aug. 28-30—Pacific General Meeting, American Institute of Electric Engineers, Pasco, Wash.

Aug. 31-Sept. 1—Midget Airplane Races, Ft. Wayne, Ind.

Sept. 1-15—Sixth International Aeronautical Conference, Royal Aeronautical Society and Institute of the Aeronautical Sciences, Folkstone and London, England.

Sept. 2-8—1957 Flying Display, Society of British Aircraft Constructors, Farnborough, England.

Sept. 3-14—11th General Assembly, International Union of Geodesy and Geophysics, in conjunction with International Geophysical Year, University of Toronto, Canada.

Sept. 7—Second Annual Convention of the OX-5 Club, Hotel Phillips, Kansas City, Mo.

Sept. 8-13—Second Annual Course on Investment Castings, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 9-13—Annual General Meeting, Interland Auditorium, Cleveland, Ohio.

Sept. 13—Third Pacific Area National Meeting, American Society for Testing Materials, Sheraton-Palace Hotel, San Francisco, Calif.

Sept. 14-15—Meeting of Antique Airplane Assn., Ottumwa, Ia.

Sept. 15—1957 Garden Party and Flying Display, Royal Aeronautical Society, Wisley Aerodrome, Weybridge, England.

(Continued on page 6)

AVIATION WEEK • AUGUST 19, 1957

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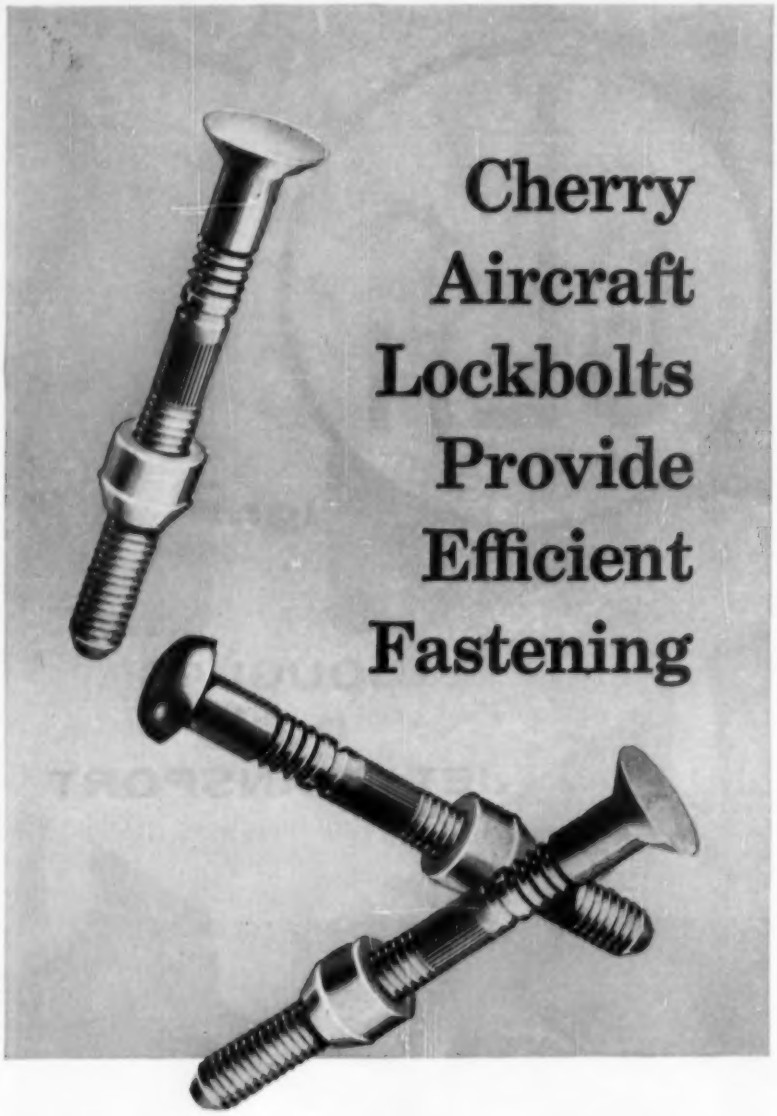

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AVIATION CALENDAR

(Continued from page 5)

Sept. 23-25—Fall Meeting American Society of Mechanical Engineers, Statler Hotel, Hartford, Conn.

Sept. 25—Pratt & Whitney Aircraft Engine Maintenance and Operation Forum, sponsored by Southwest Airmotive Co., Melrose Hotel, Dallas, Tex.

Sept. 26-27—Fifth Michigan Aeronautics Conference, jointly sponsored by University of Michigan Transportation Institute, Western Michigan University, and The Aero Club of Michigan, Alpena, Mich.

Sept. 28-29—North Central Regional Conference, Civil Air Patrol, Town House Hotel, Kansas City, Kans.

Sept. 30-Oct. 5—National Aeronautic Meeting, Aircraft Production Forum & Aircraft Engineering Display, Society of Automotive Engineers, Hotel Ambassador, Los Angeles.

Oct. 2-4—Tenth Annual Meeting and Forum, National Business Aircraft Assn., Cosmopolitan Hotel, Denver, Colo.

Oct. 5—First Annual Awards Banquet, Society of Experimental Test Pilots, Beverly-Hilton Hotel, Los Angeles.

Oct. 7-9—13th Annual National Electronics Conference, Chicago, Ill.

Oct. 7-10—Triennial Inspection, Lewis Flight Propulsion Laboratory, Cleveland.

Oct. 7-12—Eighth Annual Congress, International Astronautical Federation, Barcelona, Spain. For details write: IAF, 35 Lowell Rd., Concord, Mass.

Oct. 8—Tenth Annual Airport Development and Operations Conference, Onondaga Hotel, Syracuse, N. Y.

Oct. 9-11—National Fall Convention, Society for Experimental Stress Analysis, El Cortes Hotel, San Diego, Calif.

Oct. 10-11—National Noise Abatement Symposium, Sherman Hotel, Chicago, Ill.

Oct. 21-22—Canadian Aeronautical Institute-Institute of the Aeronautical Sciences Meeting, Montreal, Canada.

Oct. 21-23—Conference on new developments in the field of power, American Society of Mechanical Engineers, Americus Hotel, Allentown, Pa.

Oct. 24-25—Fourteenth Annual Display, Aircraft Electrical Equipment, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 28-31—Second Winter Meeting, American Nuclear Society, Henry Hudson Hotel, N. Y.

Oct. 28-29—Third Annual Meeting, Association of the U. S. Army, Sheraton-Park Hotel, Washington, D. C.

Oct. 28-30—Annual East Coast Conference on Aeronautical and Navigational Electronics, Fifth Regiment Armory, Baltimore, Md.

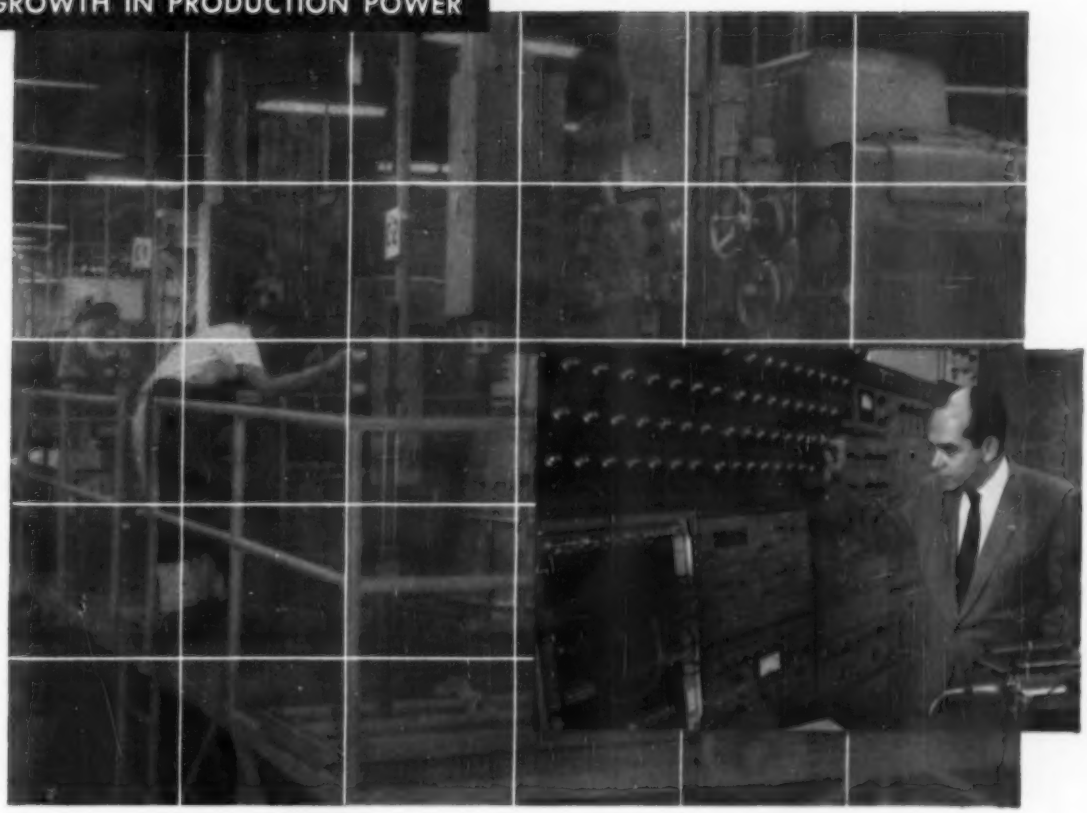
Oct. 28-31—National Industrial Packaging & Handling Exposition, Atlantic City, Convention Hall, N. J.

Oct. 30—Aviation Electrical Equipment Display, U. S. Grant Hotel, San Diego.

Nov. 5-7—Joint Military-Industry Guided Missile Reliability Symposium (limited to those with Secret security clearance), Naval Air Missile Test Center, Pt. Mugu.

Nov. 6-8—Third Annual Symposium on Aeronautical Communications, Hotel Utica, Utica, N. Y.

GROWTH IN PRODUCTION POWER



At Temco GROWTH tells the story

Growth — in production and technical computing capacities, for example—tells the Temco success story.

Through the acquisition of new and advanced production machines, such as six large Bullard turret lathes installed recently, Temco's manufacturing capabilities have increased manyfold during the past few years.

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It is not surprising that Narmco products are uniformly preferred by leading U. S. and Canadian airframe and missile manufacturers. Narmco's record of supplier dependability... of engineering and design know-how... of production-line-to-flight-line technical field service... of recognized leadership in organic structural materials development... all these contribute to this industry-wide acceptance of products bearing the trade names Metlbond®, Conolon®, and Narmtape®.

Flight service records on operational aircraft, extending back more than a decade, confirm the integrity and dependability of Narmco structural adhesives and laminating materials. Such records explain the confidence with which airframe and missile manufacturers select Narmco products when designing high performance air weapons of tomorrow.

NARMCO

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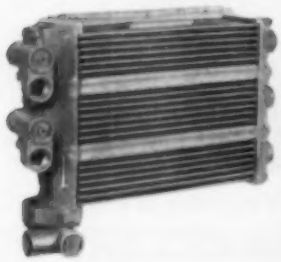
Fahrenheit's right every flight . . . with Harrison on board! Harrison oil coolers keep vital temperatures in check on transmissions and engines . . . allowing 'copters to fly faster, farther and carry heavier payloads than ever before. These oil coolers are compact, save weight and space. They're specially designed to do the job and do it better. You'll find Harrison handling the heat in every line of industry and defense . . . from hydraulic presses to supersonic jets. That's because every Harrison product is backed by over 46 years' experience in producing top-quality heat-control equipment. If you have a cooling problem, look to Harrison for the answer.



Harrison oil coolers level heat for all kinds of aircraft—from small private planes to intercontinental bombers.

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TEMPERATURES MADE TO ORDER

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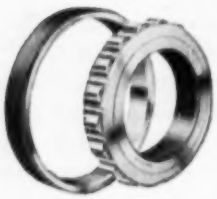
RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.

WHO is America's No. 1 source of aircraft roller bearings?

HYATT—naturally!

WHY?



Another GM contribution to aviation progress

1 **HYATT HAS MORE EXPERIENCE:** As America's *first* and *foremost* cylindrical roller bearing builder, we're the acknowledged leader in the field. Our extra "know-how" means extra help in solving tough temperature and speed problems.

2 **HYATT HAS THE TOOLING:** It's one thing to produce a successful prototype—but something else again to *reproduce* it in quantity. We have the tooling and electronic controls to assure you prototype *quality* on a *quantity* basis.

3 **HYATT HAS AN OPEN MIND:** We're glad to explore new and unorthodox bearing designs proposed by aircraft engineers. We'll pool our skill with *yours* to solve the problem.

Remember—when you've got to break a "bearing barrier," you can get MORE help from HYATT! For size ranges and load ratings of HYATT Precision Aircraft Bearings, request Catalog A-56 from Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT HY-ROLL BEARINGS FOR AIRCRAFT INDUSTRY

OFF THE DRAWING BOARD... INTO BEING

The future is being shaped today on the drawing boards at Bell Aircraft. Important developments in such fields as guided missiles, aircraft, inertial guidance, nucleonics, rocketry, electronics and helicopters are advancing steadily.

The results of Bell's continuous research programs and progressive, straight-line thinking are reflected in such current realities as the GAM-63 Rascal, a long range strategic air-to-surface guided missile built for the USAF—the automatic Aircraft landing system, for the Navy, Air Force and commercial application—the XH-40, first helicopter with turbine power—and the recently unveiled X-14, a new type aircraft that takes off and lands vertically but flies like a conventional jet.

With such major developments to its credit, a keenly creative, active organization like Bell Aircraft works confidently toward future contributions both to national defense and civilian industry—and to proving again and again that the surest way to get an idea off the drawing board and into being is to assign the task to Bell.

BELL Aircraft corp.

BUFFALO N.Y.

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Toward new frontiers of flight

Trimming vital years from the nation's aircraft development program, A-C equipment is aiding in research by the USAF's Wright Air Development Center, NACA's Langley and Moffet Fields, and major producers of aircraft and engines.

AEDC Consulting Engineers: Sverdrup & Parcel, Inc.

Allis-Chalmers Compressors

develop supersonic and hypersonic air speeds to test planes and missiles

Flight conditions at two, three, ten times the speed of sound are duplicated with scale models and for full-size jet engines at the U. S. Air Force's Arnold Engineering Development Center, Tullahoma, Tennessee.

This photo shows some of the Allis-Chalmers equipment used to whip up these tremendous air speeds.

Axial and centrifugal compressors with a combined rating of four and one-half million cubic feet of air a minute... driven by 300,000 horsepower of electric motors, with all necessary power transformers and control equipment, are among the drive systems installed in the Center's three laboratories.

Allis-Chalmers furnishes axial flow, centrifugal and rotary compressors for all wind-tunnel and engine test applications.

Other Equipment Available to Simplify Engineering

Allis-Chalmers also builds transformers, control, switchgear, motors, and unipolar generators for use in wind-tunnel and test facilities. For information, contact your nearby A-C office or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

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ROTARY?

LINEAR?

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Rotary Actuator Model 1524

Motor: 400 cycle 115V. single phase thermal protected explosion proof Western Gear motor; 10,000 RPM output speed; meets MIL-M-7969A specs. Actuator provides 100 RPM at 50 inch pounds normal rated load, 150 inch pounds maximum starting load. Available with limit switches to control number of revolutions of output shaft and slip clutch to provide for overload protection or prevent damage to driven equipment. Actuator meets MIL-A-8064 and MIL-E-5272 specs. Is equipped with emergency crank for hand operation. Can be supplied with AN connector. Total weight 3¾ lbs.

Linear Actuator Model 1965

Electromechanical ball bearing jackscrew powered through reduction gear box by 26 volt totally enclosed D.C. motor. Provision on gear box for manual operation through flexible drive shaft. Integral with unit are limit switches for accurate positioning and non-jamming mechanical stop at extend position of jackscrew to absorb full output of driving motor. Linear travel under normal operating load of 450 lbs. over a maximum operating stroke of 14.92 inches is 2.00 inches per second minimum, 3.00 inches maximum. Equipped with manual control system with provision for emergency hand crank operation. Weight is 12 lbs. 5 oz. This actuator is typical of a wide range of linear units capable of axial thrust loads from 100 to 100,000 pounds.

HERE'S WHY YOU SHOULD INVESTIGATE *Western Gear*

Western Gear is one of the nation's foremost manufacturers of actuators and as such has designed thousands of units. In many cases prototype models exist which lend themselves to economical modification and production. The "plus" factor is that they are actuators of proven design!

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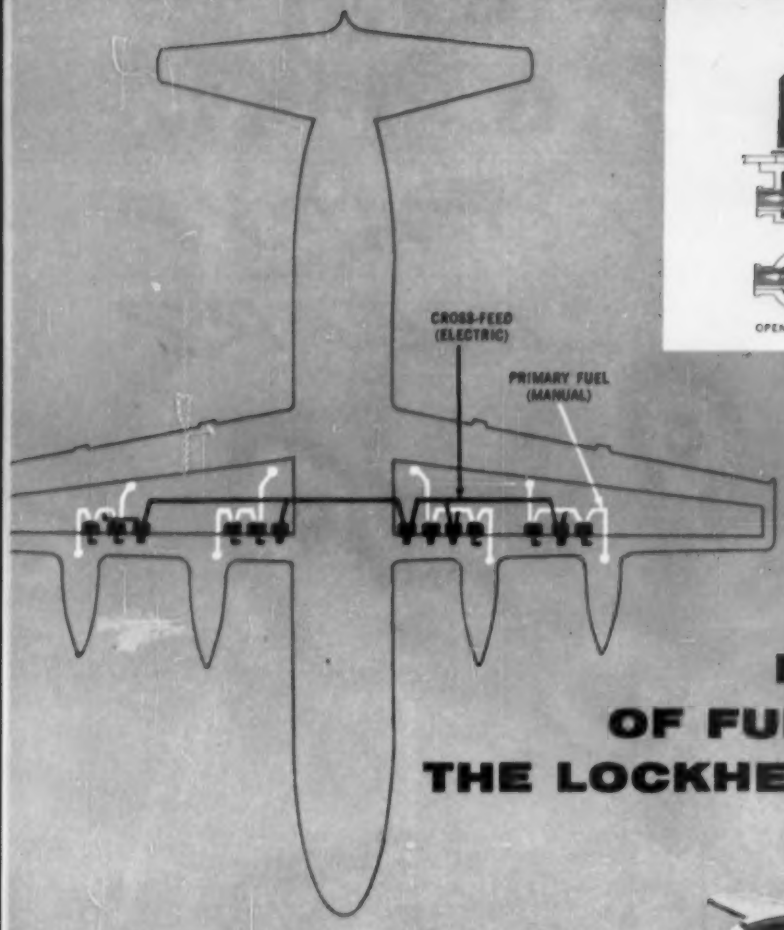

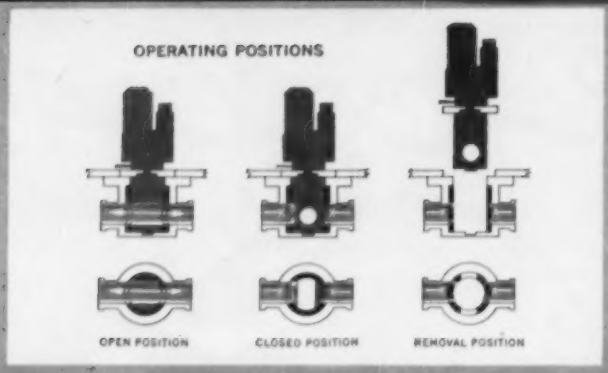

Wing section shows typical mounting position for both manual and motor-operated fuel valves.

NEW KIND OF FUEL VALVE FOR THE LOCKHEED ELECTRA

AV-16 motor-operated fuel valve. "Electra" has 5 to control cross-feed.

AV-16 manual fuel valve. "Electra" has 8. Actuators can be removed without draining tanks or breaking fuel lines.

Lockheed issued this challenge: the wing configuration of "Electra" called for an entirely new concept in immersible fuel control valves. In open competition with other valve manufacturers, General Controls met this challenge head-on and was selected because of its volume production reputation and design superiority. The advanced General Controls design best met Lockheed's requirements—in operating characteristics, unique accessibility for simplified maintenance and dependable performance under all operating conditions.

Now all fuel lines are routed *through* the integral wing tanks, saving valuable space for vital engine controls. The valve actuator can be removed for service without disconnecting fuel lines or draining tanks.

It is this ingenuity that causes important aircraft manufacturers like Lockheed to rely on General Controls for automatic and manual valves. If automatic controls figure in your specifications, contact...consult...General Controls.

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AIRCRAFT CONTROLS DIVISION
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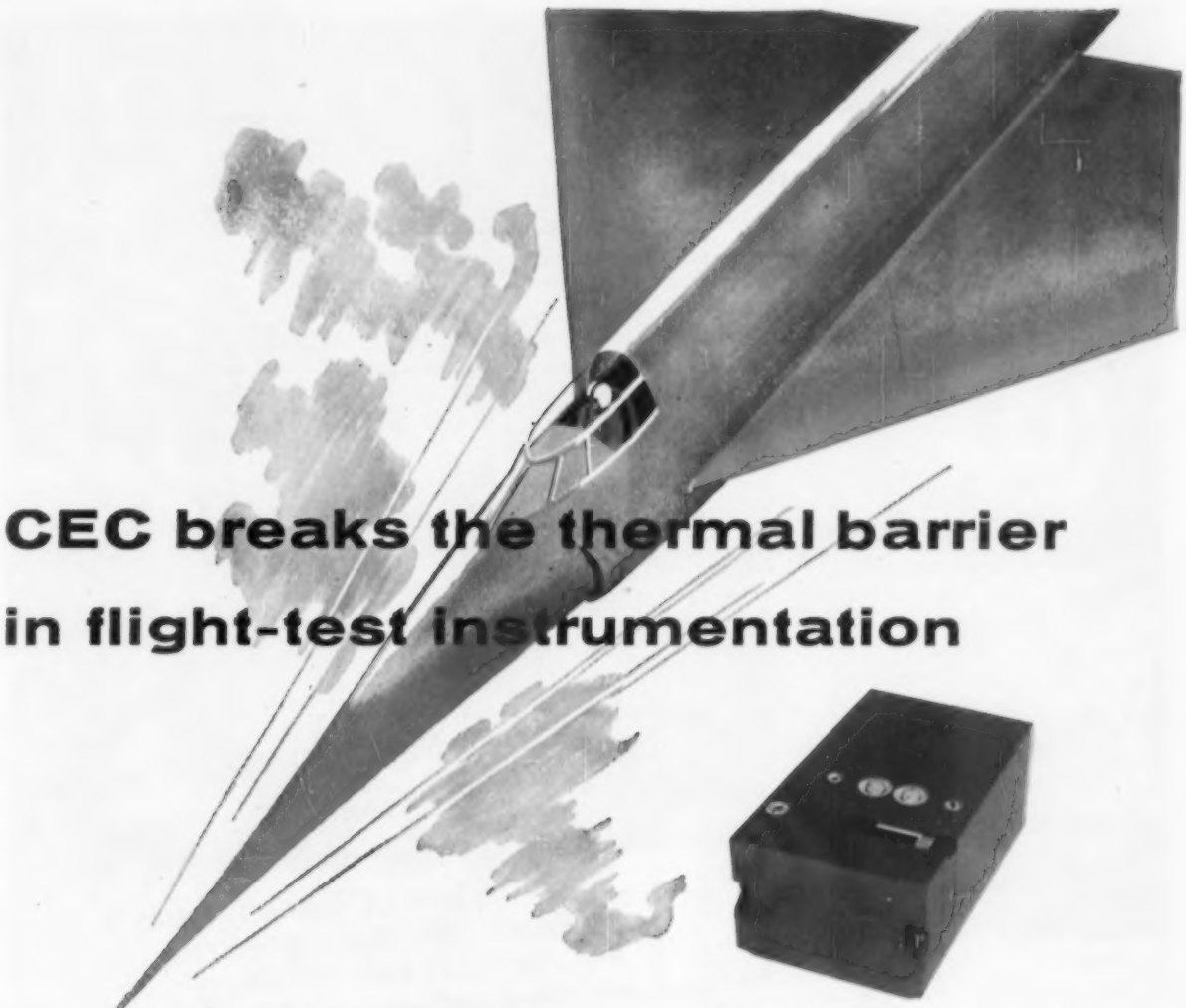


CEC breaks the thermal barrier in flight-test instrumentation

—*with a new high-temperature oscillograph*

A significant *first* in oscillograph recording, CEC's unique 5-122 operates in a temperature range of −65°F to +250°F at altitudes to 120,000 feet. Twenty-six channels (plus two static reference traces) can be recorded at writing speeds in excess of 12,000 inches per second. The 5-122 also meets the challenge of minimum size, consists of three small, separate modules—oscillograph and magazine, master timing unit, and control unit. Both the control and master timing units can be installed in remote locations.

Other features include new jump-speed selection method, flash timing, and improved automatic record identification systems; explosion-proofing in accordance with military specifications: crash-resistant magazine; and provisions for synchronizing the 5-122 into an over-all data accumulation system. Compact size is 11″ wide by 8″ high by 18½″ long. Weighs 80 lbs. fully loaded, 55 lbs. without magazine. Power requirements: 200 volts, 400 cycle, 3 phase. Contact your nearby CEC field office, or write for Bulletin CEC 1585-X3

—*and 7 new high-temperature galvanometers*

Another important *first* in flight-test recording is CEC's new family of High-Temperature Galvanometers. Accuracy is guaranteed in ambient temperatures to 250°F for extended periods with a flat response from 0 to 3000 cps. Contact your CEC field office, or write for Bulletin CEC 1528-X9.

Consolidated Electrodynamics

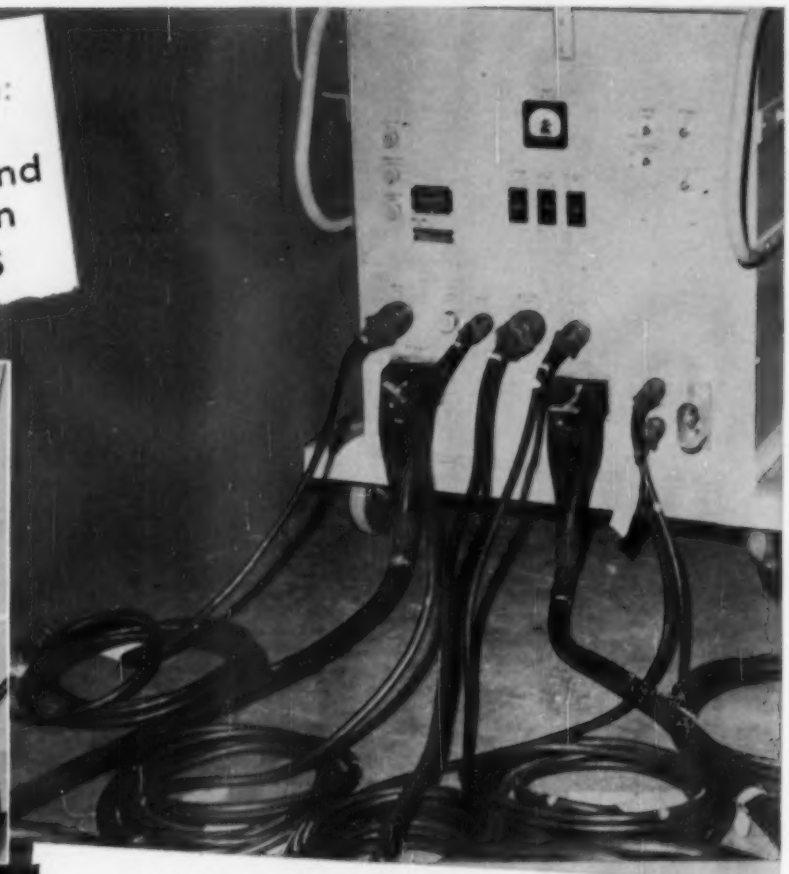
300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

Design Problem:

226

Control, Power and Instrumentation CIRCUITS



SPECIFICATIONS

ELECTRICAL

Capacitance load within cable held to 40 uuf/ft • Cross talk attenuated to a 40 db level • Voltage breakdown 3000V • Leakage resistance 75 megohms/1000 ft. maximum • Conductor sizes and types: #22; #22-TPSJ • Floating shields.

PHYSICAL

Diameters: ¾" to 1 19/32" • Lengths: 2' to 1000' • Cable Configuration: 6, 9, 10, 12, 24, 41, 61 and 63 conductors •

Connectors:
AN type A and B
Cannon DPD2
1) Molded 90° attachment
2) Metal back shell
} Each with mechanical engaging mechanism

Bend radius: Four times cable diameter, retaining flexibility at −65°F.
Conductors: Number coded every 2" inside of cable.

ENVIRONMENTAL

Reliable operation from −65°F. to +200°F.
Neoprene jacketed to withstand severe abrasion: trucks running over cable; dragging along rough ground; burial.

Resistance to oils, fuels, acids, liquid oxygen, fungus, ozone and sunlight.
Completely waterproof and submersible.

Solution: 8 RELIABLE, COMPACT, VERSATILE PACIFIC AUTOMATION PRODUCTS Engineered Electronic Cables

The eight electronic cables installed on the above junction box comprise the 226 vital control, power and instrumentation circuits for check-out of the Chance-Vought REGULUS I MISSILE.

They were designed and manufactured by Pacific Automation Products who assisted development engineers in the design of this system – keeping the number of cables to a minimum, fulfilling the circuitry requirements, preserving functional versatility, and maintaining reliability under exacting operating conditions.

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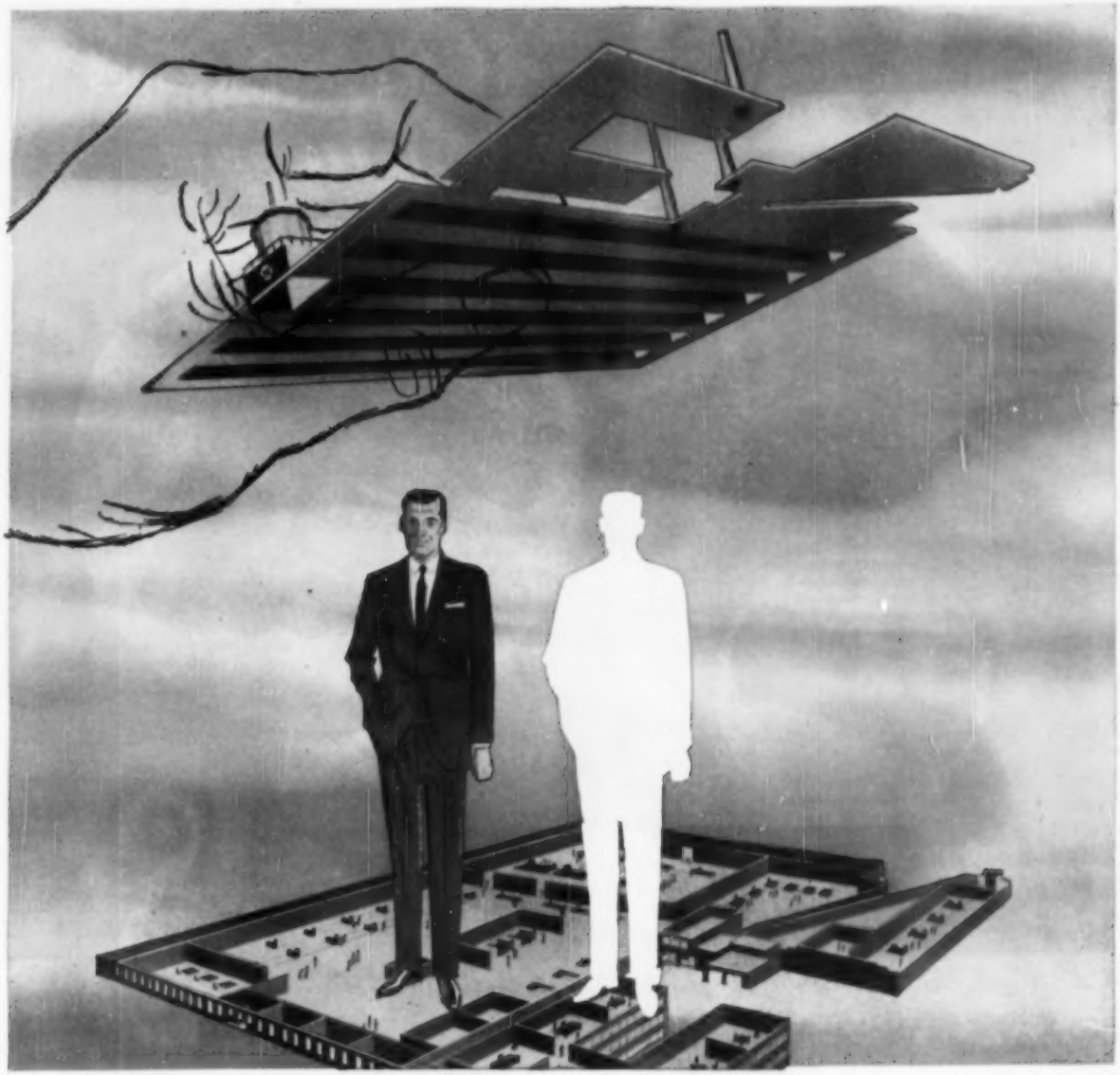

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RESEARCH AND MARKETING

Mary Whitney Fenton, Judith P. Wheeler

AMC Assigns Missile Support Functions 26
► Air Materiel Areas are given support responsibility in first step of plan to revamp AMC logistics.

CAA Says Jet Airliner Problems Ease 37
► Second jet age planning report is issued by CAA in effort to put jet problems in perspective.

Trident Blends Simplicity, Performance 50
► Uncertain future faces French mixed powerplant interceptor because of economic situation.

MISSILE ENGINEERING
Navaho Fired Successfully 29
Nose Cone Tests Planned 65

AERONAUTICAL ENGINEERING
Lulko Engine 30
Gyron Details 31
Convair Converts F-102As 63
C-46 Changes Meet CAB Ruling 71
Army Lists Jeep Requirements 129

AVIONICS
Maser Has Promise, Drawbacks 76
Radar Bolsters ICBM Defense 28
DEW Line Goes Operational 87
Filter Center 89
New Avionic Products 90

BUSINESS FLYING
Historic Aircraft Bring Profit 135
Private Lines 141

HUMAN FACTORS
Suit for Supersonic Flight 32
Human Factors Emphasized 33

AIR TRANSPORT
REAL Orders Convair Eland 38
Eastern Wins Nonstop Route 38
Russia Turns to Feederlines 39
Flameouts Trouble Comets 40
CAB Fare Probe on Financing 41
Smith Leaves Slick 34
Airline Observer 43
Airline Traffic Table 47

SAFETY
Pilot Flew Into IFR Condition 145

MANAGEMENT
Nuclear Ramjet Study 27
Radar Bolsters ICBM Defense 28
'58 Procurement Cuts Near End 30
British Order Rocket Jet 34
Nuclear Engine Project Cut 34
Who's Where 23
Industry Observer 23
Washington Roundup 25

Calendar 5
Letters 166

EDITORIAL
Cleaning Up the Pentagon 21

COVER: Backbone of Pratt & Whitney Aircraft's production program are the J75 and J57 turbojets shown together with afterburners for the first time. J75 produces about 23,000 lb. thrust with afterburner and is less than three inches larger in diameter and about two feet longer than the J57 rated at about 17,000 lb. thrust with afterburner. J57 is about 20 ft. long with afterburner and has maximum diameter of about 48 in. J57 weighs about 5,000 lb. P&WA Connecticut plant and Ford Aircraft Engine Division in Chicago have produced nearly 11,000 J57s. First production J75 deliveries have been made by P&WA for Republic F-105, Convair F-106 and Chance Vought F8U-3 programs with the engine also slated to power production versions of the Martin P6M SeaMaster. Both J57 and J75 feature split compressor designs.

Picture Credits:
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EDITORIAL

Cleaning Up the Pentagon

There is a new crop of jokes circulating in Washington these days on the fact that one of the nation's leading soap manufacturers, Neil McElroy, president of Procter & Gamble, is succeeding Charles E. Wilson as Secretary of Defense. Main point of the quips is whether an Ivory Soap salesman will be able to "clean up" the current Pentagon mess. There is little doubt among experienced Pentagon observers that Mr. Wilson is leaving a mess in the Pentagon that would tax the talents of the most able "clean-up" man who could possibly succeed him. And in evaluating Mr. McElroy's performance in the years ahead, it will be necessary to bear in mind the nature and the magnitude of the legacy left by Mr. Wilson.

There have been significant changes in the Pentagon during Mr. Wilson's regime—the longest of any Secretary of Defense since the post was created in 1947. Most significant has been the changing ratio of American airpower versus Soviet airpower. At the beginning of Mr. Wilson's regime, U.S. airpower enjoyed an unquestionably significant superiority over Soviet airpower and as a result was a major support of U.S. foreign policy.

Today, top Pentagon brass admit that the Soviets have surpassed U.S. airpower in the quantity of operational jet aircraft and only argue about the narrowing degree of U.S. qualitative superiority in aerial weapons systems.

Mr. Wilson and his policies cannot of course be blamed for the entire state of this affair as much of it is accounted for by the tremendous drive the Soviets have made in increasing their airpower potential across the board, from helicopters and transports to intercontinental bombers and ballistic missiles. However, in the face of overwhelming concrete evidence of this Russian acceleration, Mr. Wilson has administered policies that have had the effect of reducing both the quantity and quality of U.S. airpower, both now and for years to come. Even if immediate and complete antidotes were administered to the Wilson policies it would still take several years of irreparably lost time for airpower to fully recover from their effects.

While Harold Stassen, the President's special agent on disarmament, and Secretary of State John Foster Dulles have been negotiating with Soviet delegations on disarmament, the Defense Department under Mr. Wilson has been engaged in unilateral disarmament that will, unless it is quickly checked, steadily deteriorate the U.S. position at the international bargaining tables.

The excuse for this unilateral disarmament that is materially reducing both the size and effectiveness of U.S. airpower is financial. The Defense Department policies during Mr. Wilson's regime have increasingly placed more emphasis on fiscal ceilings and less emphasis on forces sufficient to meet U.S. requirements. Mr. Wilson himself admitted this with his characteristic candor at a recent Pentagon press conference.

However, one of the major causes of the mounting defense expenditures with little commensurate increase in military effectiveness has been the triplication of weapons development, particularly in the missile field, that grew to the size of a major crisis during the years of Mr. Wilson's Pentagon stewardship. Congressman George Mahon, of Texas, who heads the military subcommittee of the House Appropriations Committee, put his finger on the pulse of this problem when he recently said, "We can't afford any longer to equip all the services to fight the whole war by themselves." No responsible defense expert in Congress or the Pentagon believes that the answer to an adequate modern defense system is simply more money. It is becoming increasingly clear that the answer is to get $38 billion worth of genuine defense capability from the $38 billion that is being spent annually. Few would seriously claim that the American people are getting their money's worth in defense now.

The growth of triplication in weapons development has swollen the defense budget abnormally and the stop and start procurement and development programs that result from the frantic efforts to keep under a fiscal ceiling have wasted billions of the defense budget without producing any useable weapons. Roles and missions of the three military services are essentially unchanged from those established at the Key West conference in 1948 although none of the services have paid more than lip service to these definitions. The meat ax economy measures forced by the immediate fiscal problems are also producing a major imbalance in the airpower program. For example, the intercontinental ballistic missile program is still going full blast with top priority, overtime and other measures that have run its cost to nearly double the original estimates in order to get an operational weapon at the earliest possible date. At the same time, the development of an aerial logistics system, vital to the successful war and peacetime operation of ballistic missiles, has been completely abandoned and all effort in this field stopped on the grounds of insufficient funds. Many Pentagon missile experts are still trying to figure out how they can field, operate and support a ballistic missile weapons system without the necessary aerial logistic system.

In a relatively minor field compared to the problems cited above, Mr. Wilson's regime has contributed to building the Pentagon overhead without much results to show for the additional money. The office of the Secretary of Defense has grown in true bureaucratic fashion during the last four years from a small, advisory type group to a gigantic paper mill laced with dozens of assistant secretaries of defense who now constitute one of the major bottlenecks in producing a Pentagon decision.

As a result of the financial problems created by the triplication of weapons development and overhead growth, the airpower program has been cut back and stretched out with the scope and tempo of research and development significantly retarded. For more money we will get fewer aerial weapon systems later than the normal pace of technological development could provide them.

These are the kind of problems Mr. McElroy will face in becoming the next Secretary of Defense. He will need all of the help he can get from the Congress, the military, the executive branch of the government and the American people if he is to effectively tackle and solve them. Much of the future safety of this country will depend on how successfully he makes this effort and the degree of support he gets from all concerned —**Robert Hotz**

THERMISTOR SYSTEMS PLAYING BIG ROLE IN AIRCRAFT APPLICATIONS

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In the Front Office

Adm. Joseph J. Clark (USN, ret.), a director, Alaska Airlines, Inc.

Elmer B. Ott, president, Ray-O-Vac Co., Madison, Wis. Mr. Ott succeeds **Donald W. Tyrrell** who continues as board chairman.

Paul Hershey, president, and **William J. MacGowen**, general manager, Penn Keystone Corp., West Conshohocken, Pa.

Lt. Gen. Patrick W. Timberlake (USAF, (ret.), corporate vice president, Northrop Aircraft, Inc., Hawthorne, Calif.

Arthur H. Jones, vice president-defense planning, Avco Manufacturing Corp., New York, N. Y.

Donald L. Driscoll, vice president-contracts and sales, Transval Engineering Corp., Culver City, Calif.

Gerald J. McCaul, vice president-contracts and service, and **Myron G. Domsitz**, vice president-research and development, Simmons Aerocessories, Tarrytown, N. Y.

Robert J. Lang, a vice president, Aircraft Engineering & Maintenance Co., Oakland, Calif.

William P. Hindman, vice president, newly established Advanced Products Division, ACF Industries, Inc., Milton, Pa.

Capt. Hamilton O. Hauck, director, Guided Missiles Division, Bureau of Aeronautics, USN, Washington, D. C. Capt. Hauck succeeds **Col. Robert E. Galer** (USMC), retired.

Honors and Elections

Edward P. Curtis, former special presidential assistant in charge of the Aviation Facilities Planning Group, has been named Mr. OX5 of 1957.

The 512th Fighter Interceptor Squadron, flying out of RAF station Bentwaters, Great Britain, has been named the outstanding air defense squadron by the U. S. Air Force, and Gen. Thomas D. White, USAF Chief of Staff, presented the Hughes Achievement Award to the squadron commander, Lt. Col. John J. Ruettgers, at the seventh annual reunion of the Night Fighter Association in Washington, D. C.

Changes

Donald B. Otis, director of planning, Military Products Division, International Business Machines Corp., New York, N. Y.

Theodore E. Dinsmoor, deputy group executive, Defense Products Group, American Machine & Foundry Co., Alexandria, Va.

R. R. Hoover, assistant chief engineer-administration, Convair, Division of General Dynamics Corp., San Diego, Calif. **Richard P. White** succeeds Mr. Hoover as chief design engineer. Also: **L. E. Ottom**, F-102 senior project engineer.

Harry M. Stephey, manager of advanced sales-missile guidance section, Heavy Military Electronic Equipment Dept., General Electric Co., Syracuse, N. Y.

Frank L. Moncher, director of engineering, Aro Hydraulics Division, Vickers, Inc., Detroit, Mich.

INDUSTRY OBSERVER

► North American's high-speed, high-altitude X-15 research vehicle will use the bobsled upward ejection seat developed by Convair as part of industry's Crew Escape Systems Committee effort (AW May 6, p. 94).

► **Allison's Model 550 twin spool turboprop engine is now running on the test stand at the Indianapolis, Ind., plant. Model 550 delivers about 5,000 eshp. and was developed entirely by General Motors Corp. private funds in the new Allison jet development laboratory facilities.**

► Navy plans to expend $15 million in Fiscal 1958 on new test and support facilities for its Polaris fleet ballistic missile, including a new research and development facility in California's Santa Cruz mountains. Funds also provide for expansion of present facilities at Patrick AFB, Fla.; Naval Ordnance Laboratory, White Oak, Md., and industrial support facilities at Aerojet-General in Sacramento. Lockheed will deed 240 acres to the government for the new facility.

► **Maximum gross weight for the Ilyushin Model 18 Moscow turboprop transport is about 127,600 lb.—about the same as the Douglas DC-7B and approximately 14,000 lb. heavier than the Lockheed Electra turboprop transport.**

► Main differences between the Tu-110 four-jet Russian transport and its earlier twin jet predecessor, the Tu-104, is an additional four feet added to the fuselage and about eight feet added to the wing span to accommodate the additional engines. Tu-110 has a maximum gross weight about 22,000 lb. heavier than the Tu-104. Re-designed flaps also have been incorporated in the Tu-110 to get slower landing speeds and shorter landing runs.

► **Some industry sources believe Gen. D. H. Baker, former director of procurement and production for the Air Materiel Command, was overly pessimistic in predicting that there will be 57 million sq. ft. in surplus facilities by the end of 1961 (AW July 1, p. 28). Reasoning is that while space needed to house actual missile airframes is not as great as that required for piloted aircraft much more space is needed for supporting missile manufacturing equipment. Such equipment, the sources say, will consume a large amount of the 57 million sq. ft.**

► Studies have been conducted at Holloman AFB, N. M., of special electronic flash procedure for photographing shock waves outdoors in connection with supersonic speeds and warhead detonation. Procedure is being developed by Harold E. Edgerton, professor of electrical engineering at Massachusetts Institute of Technology. Largest area covered thus far is 4 x 6 ft.

► **Navy hopes to complete first designs of nuclear seaplane airframes during the current fiscal year unless blocked by present expenditure ceilings. Beginning of hardware development is scheduled for Fiscal 1959.**

► Grover Loening is conducting a survey of recent VTOL and STOL developments for the National Advisory Committee for Aeronautics. NACA will use the survey in planning future VTOL-STOL research programs.

► **Navy may be forced to develop a means of automatically controlling flight of a catapulted aircraft for several seconds after launch. Point may soon be reached where catapults launching high-performance carrier based aircraft will have to reach speeds that will exert enough Gs on the pilot to cause momentary blackouts.**

► Air Force, Navy flying time will be crippled by Pentagon decision to cut Fiscal 1958 petroleum purchases between 10 and 15% in current economy drive. Heaviest cuts will be made in aviation fuels and Navy special fuel oil.

► **Mechanical translation of Russian into English will be demonstrated at Rome Air Development Center in late September. Mechanical language translation system was developed for Rome's Directorate of Intelligence Electronic Warfare by International Telemetering Corp.**

The high frontier

Far to the north of settlements, roads and railways, DEW line outposts stand guard over America. They were built with the help of Fairchild C-123 transports, which flew in the men and the construction material—even the radar antennas which now scan the arctic skies.

The C-123 commuter service to the DEW line goes on at the rate of up to eight tons of cargo per plane—and at the end of the line the landing strips have proven too rough, too hazardous for any other heavy-duty transport now in service.

The members of this polar bear club have come to depend on the C-123—just as the U. S. Armed Forces everywhere. The C-123 shares these qualities with other Fairchild aircraft: ruggedness, reliability, and ever increasing utility.

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Washington Roundup

Engine Profits

House Armed Services Investigating Subcommittee's investigation of military aircraft engine profits and procurement policies is officially off until next January as predicted by AVIATION WEEK (Aug. 12, p. 25). And it is doubtful if they will be resumed then when the extensive information the subcommittee staff has collected on 17 engine manufacturers for the five-year period 1952 through 1956 will be outdated. Members of the subcommittee headed by Rep. Edward Hebert (D.-La.) want to leave Washington when Congress adjourns in a week or so. Only one manufacturer has testified—Roy T. Hurley, president of Curtiss-Wright Corp. (AW July 29, p. 38).

GM Under Fire

However, the subcommittee last week did press charges that General Motors Corp.'s Buick-Oldsmobile-Pontiac Division failed to furnish USAF negotiators correct cost data on a $375 million contract for 599 F-84 aircraft and that USAF negotiators were too lenient in price redetermination negotiation even on the basis of the inadequate cost data available. Testimony by the subcommittee staff included:

- **In a redetermination** for forward pricing on 300 aircraft a unit price of $275,000 was negotiated. This was a compromise between General Motors' calculation of $288,000 and USAF's estimate of $262,000.
- **Subcommittee staff's calculation**—based on information also available to USAF—was $257,644 maximum or $254,073 minimum.
- **Post audit by General Accounting Office** based on "actual costs" said the correct unit price should have been $250,000.

Rep. Edward Hebert (D.La.), subcommittee chairman, objected that USAF "capitulated" to General Motors. "Air Force was not adamant," he protested, "in insisting on a price it considered fair and reasonable."

MATS Probe

Senate Commerce Committee will shortly establish a special subcommittee to make a thorough study of the operations of the Military Air Transport Service as well as MSTS. Sen. Warren Magnuson (D.-Wash.) said the subcommittee will determine "whether these services are operating beyond the scope intended by Congress." Emphasis also will be placed in the study on the cost and efficiency of MATS compared with commercial airlines. House and Senate Appropriations Committees already have directed Defense Department to channel a greater portion of transportation from MATS to commercial carriers.

Military Pay Raise

Ralph J. Cordiner, president of General Electric Co., will make another bid this week for his proposal to change present military pay scales in testimony before a Senate Armed Services Subcommittee headed by Sen. John Stennis (D.-Miss.). Cordiner headed the Defense Advisory Committee on Professional and Technical Compensation which concluded that, by boosting pay for skilled employes, Defense Department could make tremendous savings by reducing manpower turnover (AW Feb. 4, p. 37). Cordiner estimated that, if his group's recommendations were implemented, the annual defense budget could be reduced by $5 billion. Other members of the subcommittee are Sen. Harry Byrd (D.-Va.), Sen. Stuart Symington (D.-Mo.), Sen. Leverett Saltonstall (R.-Mass.), and Sen. Frank Barrett (R.-Wyo.).

Longer Hitch

Air Force, in another effort to stem the flow of costly technical personnel back to higher-paying civilian life, says future cadet pilots will have to sign for a five-year hitch rather than the present three years. An Air Force spokesman said that, under the three-year plan, a pilot spent three-quarters of his hitch training to become combat ready. At the end of three years, two-thirds of the pilots returned to civilian life.

Missile Information

USAF's Office of Information Services hopes to have a conference on relaxation of information policies regarding missile firings with outgoing Secretary of Defense Charles E. Wilson before he leaves, which will probably be around Sept. 1. Air Force feels Wilson has the background on which to base a decision. Murray Snyder, Assistant Secretary of Defense for Public Affairs, has refused to relax stringent restrictions under prodding from the House Government Information Subcommittee, headed by Rep. John Moss (D.-Calif.) (AW Aug. 5, p. 25). A memo by Snyder prohibits the disclosure of any details except confirmation of the fact that a test firing has occurred and "a brief statement" as to any casualties.

CAA Fare Deadline

Following a Civil Aeronautics Board request that the General Passenger Fare Investigation be expedited, Examiner Ralph L. Wiser last week set procedural dates and cautioned that strict adherence to the schedule is necessary. Deadline for exchange of revised exhibits is Sept. 13; rebuttal exhibits, Oct. 11; written testimony of all parties except Bureau Counsel, accompanied by surrebuttal exhibits, Oct. 25; written testimony by Bureau Counsel, Nov. 1; submission of trial briefs, Nov. 8; hearing, Nov. 18.

Airways Modernization Board

Legislation providing for the establishment of an Airways Modernization Board to monitor U.S. airways development over the next three years became final last week with the signature of President Eisenhower. At the same time, the President sent to the Senate the name of former USAF Lt. Gen. Elwood Quesada for confirmation as head of the new board. Quesada's appointment was first announced in May (AW May 27, p. 25).

Floberg to AEC

John F. Floberg, chairman of the Conference of Local Airlines, was recommended for confirmation as a member of the Atomic Energy Commission last week by Senate members of the Joint Committee on Atomic Energy.

—Washington staff

AMC Develops Missile Support System

Air Materiel Areas are given support responsibility in first step of plan to revamp AMC logistics system.

By Claude Witze

Wright-Patterson AFB, Ohio – USAF's Air Materiel Command has assigned weapon system support responsibility for missiles to five Air Materiel Areas.

This is the first step in a 10 year program to revolutionize the AMC logistics and communications system to meet the demands of missile combat capability. The Air Materiel Area will evolve into the first of a new USAF administrative unit, the Weapon System Support Manager (WSSM).

Initial assignments of missile support responsibility have been made by "family groups." They are:

- **GAR-1 Falcon and GAR-8 Sidewinder** air-to-air missiles to Middletown, Pa., Air Materiel Area.
- **GAM 63 Rascal and GAM 72 Green Quail** to Oklahoma City, AMA.
- **TM-61 Matador** surface-to-surface missile to Warner Robins, Ga., AMA.
- **IM-99 Bomarc** surface-to-air missile to Ogden, Utah, AMA.
- **SM-62 Snark, SM-64 Navaho and SM-73 Bull Goose** to Ogden AMA.
- **SM-65 Atlas, SM-68 Titan and SM-75 Thor** ballistic missile to San Bernardino, Calif., AMA.

Spokesmen for AMC's Directorate of Plans and Programs told AVIATION WEEK they anticipate about eight present Air Materiel Areas will form the "hard core" of combat unit missile support in less than 10 years. These new Weapon System Support Manager commands will take over responsibility as the Weapons System Project Office (WSPO) phases out of the research, development and procurement activity, and the missile enters active inventory. The process will be similar to that within the WSPO when AMC takes over control from the Air Research and Development Command.

AMC places strong emphasis on the fact that it is not making overnight introductions of new equipment and methods in the logistics picture.

Faster Computers Needed

Some of the equipment and methods still do not exist. Still greater networks of electronic communicators must be provided, and the business machine manufacturers face a new demand for bigger and faster computing devices. Univac, already rushed by AMC demands, probably is only a crude prototype of the machine that is needed in the next few years.

As these are introduced, all in support of missile combat capabilty and USAF economy, they will bring improvements in management techniques applicable to manned aircraft and applied at the outset to these weapons.

The start already has been made. Utilization of the Air Materiel Area as a weapon system storage site and the commander as a weapon system support manager actually is getting a try-out with conventional aircraft.

Such sites, with concentrated management authority over all spares and maintenance capability, have been established for the Century series fighters and the Boeing B-52 long-range jet bomber. Experiment will continue.

This concentration of responsibility, authority and the missing pieces that can keep an aircraft AOCP at a combat base is most appreciated by the unit commander. From now on, he will rely on a single installation within the U.S. for all his equipment, spares and maintenance support. Parts, skills, management responsibility and inventory control will be centered at one point.

Establishment of weapon system storage sites in the zone of the interior along with improved inventory controls are expected to reduce the size of AMC's physical structure in the next 10 years. The combat unit no longer will go to specialized depots for special components, such as the electronics supply depot here at Gentile AFB.

In addition, aeronautical supply and maintenance activity will phase out of the overseas depot structure. The management functions of both the U.S. specialized storage depot and the overseas depot will be assigned to the Weapon System Support Managers. Personnel for the most part will be used where the skills are in demand, at the remaining Air Materiel Areas, the weapon system storage sites or in mobile maintenance teams.

Choice of the storage site and home of the WSSM will not depend on which prime contractor is involved. With the growing introduction of missiles, AMC expects the most efficient division will be along the "family group" line used in the initial assignments. In this case, one type of airborne missile went to Middletown, another to Oklahoma City. The ballistic types are centered in California and the cruise missiles at Ogden, Utah.

Expedites Standardization

This breakdown will center particular skills in handling and maintenance of a particular type of missile at one base. It will facilitate use of interchangeable parts when this is possible. It may even expedite the constant struggle for more standardization.

In assigning managerial responsibility for the first missiles to specific Air Materiel Areas, it was made clear that AMC will continue to provide its own support for first-line weapons. Contract logistical support will be used only in research and development stage and as weapon enters obsolescence.

Prime contractors will find two new conditions facing them when missiles are predominate in the USAF inventory. There will be lower stocks of spare parts, stocks made up on the basis of more complete and accurate information about demand. On top of this, the industry will be forced to help supply information to make this possible.

For fundamentals, AMC today is looking for results by 1960 from a new Division of Logistics Research in the Directorate of Plans and Programs.

Missile System Support

Wright-Patterson AFB, Ohio—At present, there are only two items left outside the responsibility of the Air Materiel Area named as logistic support manager for a particular missile family.

They are warheads and propulsion units. Later, it may develop that other items will be added to the list, but not until some sound reason appears for the exemption.

The new Weapon System Support Manager is responsible for all other items peculiar to his assigned weapons. This responsibility covers maintenance, with maximum exploitation of field level work, supply and procurement.

In addition, support of the missile weapon system will include the provision of mobile maintenance teams available for world-wide assignment.

Air Materiel Command has anticipated the demand and in recent months provided emergency help for scattered installations from its reservoir of skilled personnel.

Area Support Teams, which can run as high as 200 to 300 men, are available to meet a crisis at any combat command installation. A hundred experts can be sent to a base in need of a major sheet metal job. Another team can be sent to the home of a unit to unravel a supply snarl, take inventory and fix new stock levels.

How B-47 Carries Rascal

Mounting of Bell GAM-63 Rascal on belly of B-47 bomber on a line with wing is shown in photo closeup. Rascal, 32 ft. long and 4 ft. in diameter, will become operational with SAC B-47s this year (AW Aug. 12, p. 31).

AEC Begins Nuclear Ramjet Study

Washington—Atomic Energy Commission has initiated feasibility studies on the application of nuclear power to ramjet and rocket engines.

First official statement that AEC is interested in the possibility of applying nuclear power to ramjets is contained in the commission's 22nd semi-annual report to Congress covering the first six months of this year.

Last September, AEC reported that it was "concerned with research and development of nuclear rocket propulsion" (AW Sept. 17, p. 25) at the N Division of its Los Alamos Scientific Laboratory, Los Alamos, N. M., and at the Livermore Laboratory in California. The announcement was a recruiting effort aimed at letting scientists and engineers know the work existed.

The current semi-annual report said AEC "continued studies" and "initiated feasibility studies" relating to application of nuclear power to ramjets and rockets. The work is being done in AEC laboratories and not by industrial or university contractors.

The report also contained the first AEC statement that atomic batteries are expected in the future to power "equipment in guided missiles and space craft."

Five types of small experimental atomic batteries have been announced so far. They convert atomic radiation to electric current. Useful life depends upon the radioisotope used, but AEC said lifetime can be "many years, and the batteries are virtually unaffected by temperature and humidity extremes."

Latest battery announced uses the radioisotope promethium 147 to power a wrist watch. It produces 20 microwatts, has a useful life of more than 5 years and is smaller in diameter than a dime. AEC also said:

• **Revisions and additions** to laboratory facilities at Los Alamos, "necessitated by nuclear and thermonuclear reactor programs and the nuclear propulsion program" and the weapons program, continued.

• **"Reactor experiments** relative to nuclear operation of turbojet engines" continued under General Electric Co. at the National Reactor Testing Station at Idaho Falls, Idaho. First powering of a turbojet by heat from a reactor took place there in 1956 (AW Feb. 4, p. 29). GE and Pratt & Whitney Division of United Aircraft Corp. are engine contractors under Air Force's aircraft nuclear propulsion program. Construction of a Low Power Test Facility also was begun at Idaho Falls.

• **Construction of facilities** at Pratt & Whitney's nuclear engine laboratory in Middletown, Conn., "proceeded satisfactorily and some portions of this complex were occupied," during the six-month period. USAF is building the plant. Pratt & Whitney was named to operate it under contract to both USAF and AEC.

• **AEC exercised an option** to buy an electronic equipment production plant known as the Pinellas Peninsula Plant, which General Electric recently completed for it between St. Petersburg and Clearwater, Fla. GE will continue to operate the plant under a contract with Sandia Corp.

• **Development continued** on "weapons employing new design principles which can be used more effectively for defensive purposes" and on "methods of reducing the radioactive contamination resulting from weapons detonations."

• **USS Nautilus** (SSN571), forerunner of Navy's missile carrying nuclear powered submarines, traveled 62,560 mi. without being refueled. Of this, it traveled 36,498 mi. fully submerged.

Radar Advance May Aid ICBM Defense

By James A. Fusca

New York, N. Y.—Defense of the North American continent against attack by intercontinental ballistic missiles is significantly closer to reality with disclosure of a fundamentally new radar technique potentially capable of extending missile detection range to distances of 2,500 mi.

Joint disclosure by Columbia University scientists and officials of USAF's Rome Air Development Center is the first on the more than $10,000,000 USAF research and development program in the field of "fine structure analysis" of radar echoes.

Fine structure analysis is a method of frequency and phase analysis of a radar return signal that permits measurement of target range and velocity with unprecedented accuracy despite signal strengths that are far below the noise level of the radar receiver before processing.

Technique's Significance

Mission of an anti-missile weapon system is to detect, identify, intercept and destroy an incoming enemy missile. Because existing radars are unable to detect missiles at ranges of more than 300 mi., primary problem of designers of such defense systems has been the short time interval between detection and arrival of an ICBM traveling at speeds near Mach 20 (AW Apr. 9, 1956, p. 43).

Columbia's new system, called ORDIR for Omnirange Digital Radar, may provide warning times up to 15 minutes from U. S. sites and even longer times from sites along the Distant Early Warning (DEW) Line.

An enemy ICBM may be expected to have the following general characteristics: range about 5,000 mi., flight time approaching 30 min., velocity at burnout approximately Mach 20, altitude at apogee (highest point of its eliptical trajectory) about 800 mi.

Radars with a maximum missile detection range of 300 mi., such as are presently proposed for use with the Army's Nike-Zeus, can defend only specific target areas because an incoming ICBM would be within range only during its period of rapid acceleration at the terminal end of its trajectory.

ORDIR equipped sites along the DEW Line potentially could detect an ICBM during an early stage of its flight which would enable a defense unit to launch an intermediate range missile to kill the ICBM near apogee.

There are two strong advantages to such a system:

- **At apogee** an ICBM would be traveling more slowly than at any other point in its flight. From the time of launching, the missile accelerates until burnout, decelerates to apogee, and then is reaccelerated during its return to earth by gravity.
- **Thermonuclear warhead** that can be expected to be used with an ICBM would be detonated over Arctic wasteland with minimum danger to military targets or civil population from resulting fallout.

Columbia Program

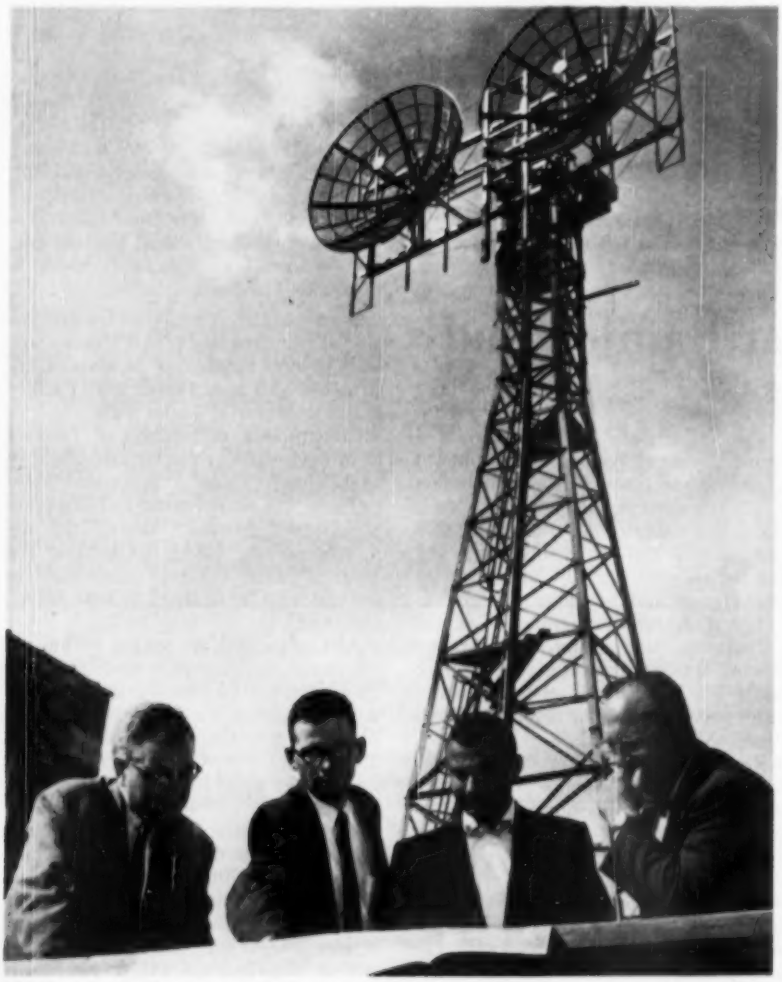
Work on the Omnirange Digital Radar system (officially titled "Long Range Missile Detection Project)" began at Columbia University's Electronics Research Laboratories in March, 1954, and the technique was first successfully demonstrated in March of this year.

Scientists of the Electronics Research Laboratories told AVIATION WEEK that the theoretical and experimental research for the project utilized a communication theory approach to achieve "a reduction in entropy of a discrete noisy (radar) channel."

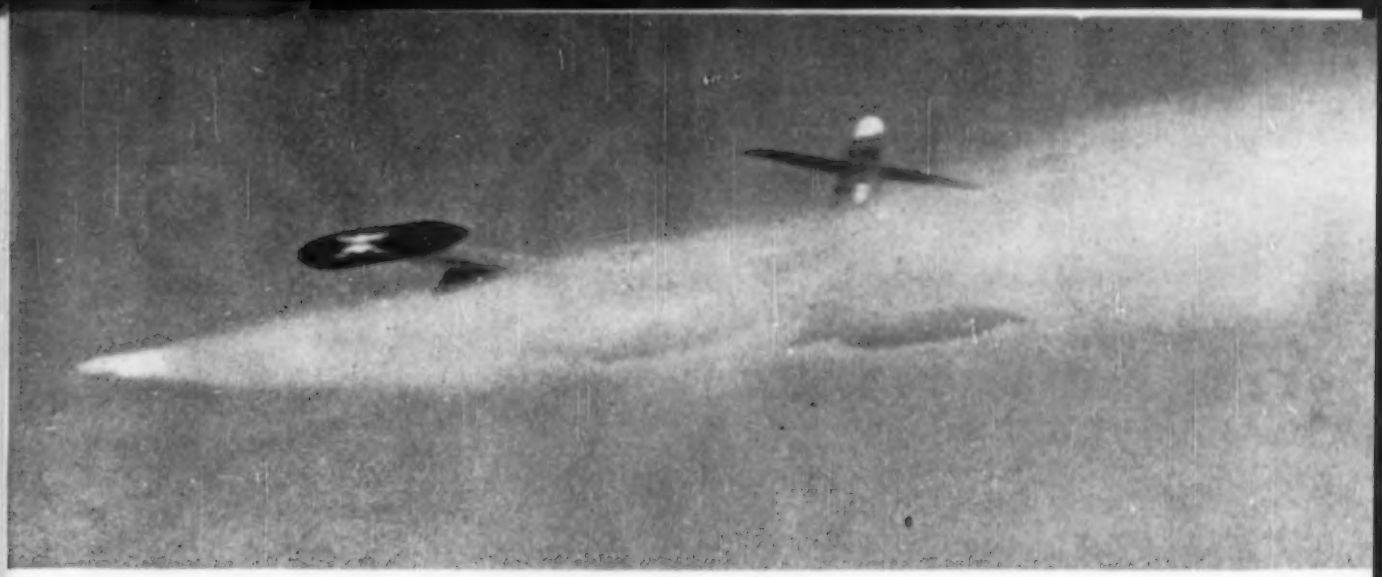
Although there are several other contractors working in the area of extending radar range by fine structure analysis, including Lincoln Laboratory, Melpar, General Electric, Sperry and Westinghouse, the Columbia program began about two years before the others and is the first to announce its results.

The new technique will have application in fields other than radar where the received signals are very weak, such as tracking of the earth satellite, scatter communications and certain phases of radio astronomy.

ORDIR is a lock and key system



ORDIR'S developers at Columbia University's Edwin H. Armstrong Laboratory, Alpine, N. J., where system has been undergoing tests. Left to right, J. H. Bose, S. Fisher, Dr. R. I. Bernstein and Prof. L. H. O'Neill. Dual parabolas of the experimental system appear in background.



F-89 Launches Genie

Nuclear warhead air-to-air missile, Douglas MB-1 Genie, is launched from Northrop F-89 Scorpion in Atomic Energy Commission test at Yucca Flat, Nev. (AW July 29, p. 33). F-89, at 18,000 ft. altitude, was on course of 280 deg. and at 450 mph. TAS. After launch, F-89 turned 90 deg. in bank at 3G acceleration to escape blast. Two other F-89s took part in test, for weapons study and data collection.

that utilizes frequency modulation of the transmitted signal and sustained coherence of the received signal to permit integration and analysis of the target echo.

Heart of the system is a highly stable crystal oscillator used to establish transmission frequency and to obtain coherence of the received signal. The major difficulty overcome in design of the system was to prevent degeneration of master oscillator stability by frequency modulation in later stages.

The receiver uses sustained coherence techniques to provide signal integration over periods up to 0.5 seconds after which it performs a spectral analysis of the signal to determine range and velocity of the target. Carrier modulation provides range data and Doppler resolution velocity data.

Because of the long integration times possible with sustained coherence, received signals far below the noise level of the radar receiver input stages can be amplified and analyzed. According to Columbia scientists, the new technique pushes signal reception to the coherence/incoherence borderline, the borderline between conventional electronics and quantum mechanics, while using conventional tubes and antennas. Beyond this borderline, they said, lies the indeterminacy characteristic of the Heisenberg effect.

Army-USAF Controversy

Army and Air Force currently are battling over who should have ICBM defense responsibility. Army has Nike-Zeus, developed by Douglas and Bell Laboratories, against which the Air Force is pitting its Wizard system, developed by Convair and Radio Corp. of America.

Nike-Zeus reportedly has a range of 100-200 mi. while Wizard, apparently anticipating the radar breakthrough, has long range capability. Air Force claims the Army system lacks both range and sophistication. Conflict is now before the Pentagon's Weapon System Evaluation Group (AW May 20, p. 23).

Pentagon sources have told Aviation Week that Columbia's development certainly strengthens Air Force's bid for anti-missile missile responsibility primarily on the basis of better mission performance. Though Nike-Zeus might provide specific target defense backup, high cost of ICBM defense systems probably will dictate cancellation of one program.

Navaho SM-64 Is Fired Successfully in Test

North American Aviation's canceled Navaho intercontinental cruise missile had a successful test firing last week from Patrick AFB, Fla., in which the missile:

- **Went through rocket-boosted launch** and acceleration, ramjet ignition, booster separation sequences.
- **Reached an altitude of** more than 75,000 ft., a height greater than that which had been programmed for the flight.
- **Reached a speed** of more than Mach 3.
- **Traveled more than 300 miles.**

Cause of the flight's termination has not yet been determined.

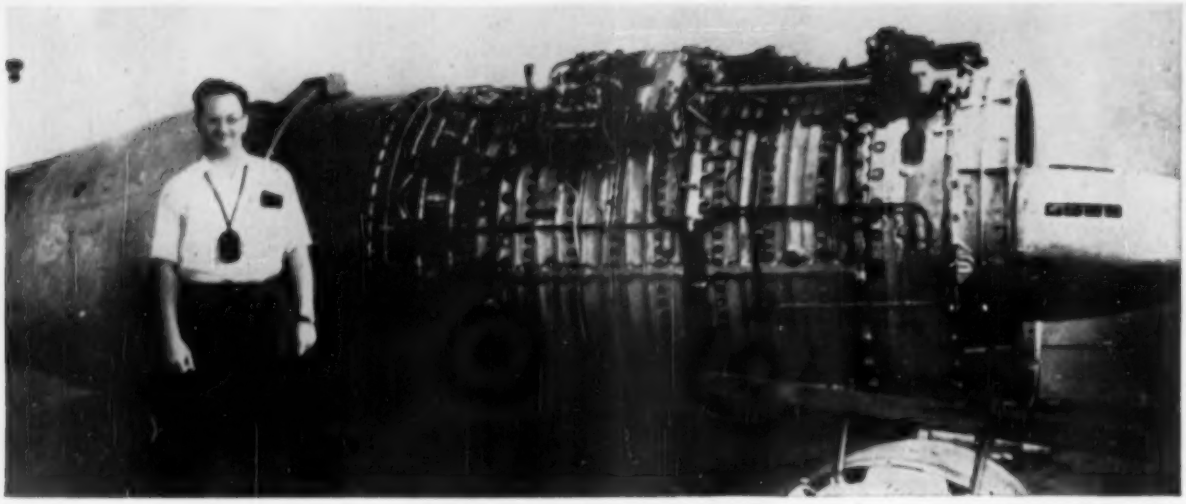
The missile was the XSM-64, known in the company as the G-26. Airframe configuration very closely resembles that of North American's X-10 research vehicle. Powerplants for the Navaho are two 48-in. ramjets, while the X-10 used two Pratt & Whitney J57 turbojets. In tests at Edwards AFB, Calif., the X-10 reached speeds of between Mach 2.1 and 2.3.

Production version of the missile, the SM-64A with a company designation of G-38, has the same airframe and propulsion as the G-26. Both use the same pure inertial guidance system developed for Navaho by North American's Autonetics Division. Both ride piggyback on the rocket booster. The G-26 employs the same two vertical butterfly-like surfaces projecting up on a slant as those used by the X-10, while the G-38 production model has only a single vertical tail located in the middle of the aft end.

Other differences:

- **G-26 uses rocket booster package** consisting of two 135,000 lb. thrust chambers developed by North American's Rocketdyne Division; flight path is a near vertical launch and acceleration to about Mach 1.5 speed required for ramjet ignition, then pushover into level cruise flight attitude. G-26 is lighter gross weight than the production version of which none has been assembled.
- **G-38 uses booster package** of three 135,000 lb. thrust chambers; flight path is a just-off-vertical launch and climb to more than 100,000 ft., booster separates en route and missile coasts over the top and, during the downward fall, develops ramjet ignition speed. It then pulls out to level flight cruise at between 70,000 and 80,000 ft. Cruise range was announced as more than 5,000 miles at design cruise speed of Mach 3.

Successful missile was fifth firing of a Navaho. The preceding four were plagued by malfunctions (AW July 15, p. 23).



Size Marks Russia's Lulko Engine

First pictures of the Russian 19,500 lb. thrust Lulko turbojet to reach the U. S. show an extremely large engine designed to handle high mass air flow. This engine, which has been in operational service for about four years, powers the Badger twin jet bomber, the Bison four jet bomber, the Tu-104 twin jet transport and the Tu-110 four jet transport. The engine is about 12 ft. long with a maximum diameter of about 50 inches. Compressor indicates about seven stages with a single spool design, extremely short combustion chamber and two turbine stages. Last stage turbine blades are extremely large, corresponding to first stage compressor blades on recent U. S. turbojets. Lulko jet indicates relatively low compression ratio well below the 12 to 1 ratio in current U. S. and British split compressor designs and correspondingly high fuel consumption rate. Clive Jenkins, British airline union official, is shown with the engine during a recent inspection trip of Aeroflot facilities. Engine was photographed at the Civil Aviation Institute in Kiev.

USAF '58 Procurement Cuts Near End

Washington—Overhaul of Air Force procurement and production program to meet expenditure ceilings is almost completed. Only major changes in the near future are expected to come in development programs.

Raising of USAF's Fiscal 1958 spending ceiling from $17.6 to $17.9 billion and lowering of progress payments and overhead were described by one Air Force spokesman last week as "the end of the streetcar line" in recent moves aimed toward readjusting procurement spending.

For the next six months, development programs will remain under very close scrutiny, however, and further cuts and stretchouts are likely. Good prospects for trimming:

• **Ballistic missiles program.** So far, this has been exempted from most of the recent economy moves, including cuts in overtime payments and overhead, even though it is chiefly responsible for USAF's rising costs. But the feeling is growing that a two-headed ICBM program, with dual development of the Convair Atlas and Martin Titan, is too costly in face of reduced spending everywhere else in USAF. Defense Secretary Charles E. Wilson already has ordered a merging of the Army Jupiter and USAF Thor IRBM programs. A three-man board composed of Maj. Gen. John B. Medaris, director of Army's Ballistic Missile Agency; Maj. Gen. Bernard A. Schriever, commander of ARDC's Ballistic Missile Division, and William H. Holaday, Wilson's special assistant for guided missiles, will combine best elements of the two developments. Both missiles use the same USAF-sponsored engine developed by Rocketdyne Division of North American Aviation, Inc. Chrysler Corp. is airframe contractor and Ford Instrument Co. the guidance contractor on Jupiter. Douglas is airframe maker of Thor, with AC Spark Plug Division of General Motors Corp. handling guidance. Speculation is that the Thor airframe and Jupiter guidance will end up in the final package.

• **Nuclear aircraft program.** As in the ICBM program, there is dual—although not duplicatory—work going on for both the airframe and engine (see p. 34), and this is considered too costly in times of austerity. Atomic Energy Commission, which also supports this development work, is also hit hard by budget trimming.

No further industry-wide briefings at the Pentagon, such as the one USAF Secretary James H. Douglas gave industry leaders two months ago (AW July 1, p. 26), are planned. Instead, representatives of procurement and research and development offices will visit plants around the country to get on the spot impressions and reports and to brief companies individually on specific projects and on the general outlook.

In Dayton, a spokesman for Air Materiel Command's Directorate of Procurement and Production told AVIATION WEEK that USAF faces an

Revised FY 1958 Expenditures

	President's Budget	Change	Current Estimate
		(in millions)	
Army	$ 9,170	—220	$ 8,950
Navy	10,389	+ 11	10,400
Air Force	17,600	+300	17,900
Defense	726	+ 24	750
Proposed for later transfer	115	—115	.....
TOTAL	$38,000	0	$38,000

austerity budget for authorized programs for the next few years.

He said USAF and AMC will have to exercise great care to be certain that the necessary part of the industrial complex "does not die on the vine."

Meanwhile, major aircraft companies have accepted USAF's challenge on expenditures, he said. They began cutting back immediately after Secretary Douglas' briefing to industry leaders.

Most noticeable reductions have been in personnel, primarily through attrition but also through some layoffs.

These are latest Defense Department, Air Force and Navy actions designed to adjust military and industry to budget ceilings:

• **New expenditure estimates** resulting from congressional action and review of military programs raised USAF's total from the $17.6 billion proposed in the President's budget early this year to $17.9 billion, raised Navy from $10.389 to $10.4 billion and cut Army from $9.17 billion to $8.95 billion (see box p. 30).

• **Air Force says it will cut** its civilian payroll by 5% by Nov. 1, reducing overseas and domestic civilian employment by approximately 20,000. Attrition will take care of a good part of this. This follows plans to cut USAF headquarters overhead by 12% in Fiscal 1958.

• **USAF called on industry** to make "corresponding cuts" in expenditures chargeable to payroll and other overhead in cost plus fixed fee contracts. Actually, much of the overhead cutting —most of it in personnel costs—already is well under way in industry. USAF estimates that "this and other actions previously announced" still will leave aircraft industry employment "somewhat above the level of early 1956," which was close to 800,000 (AW Aug. 5, p. 26). Average employment level in avionics is expected to increase, Air Force said. It also pointed out that the 5% figure now being mentioned is a part of the general 12% overhead reduction suggested by Secretary Douglas sometime ago as a goal for industry to seek.

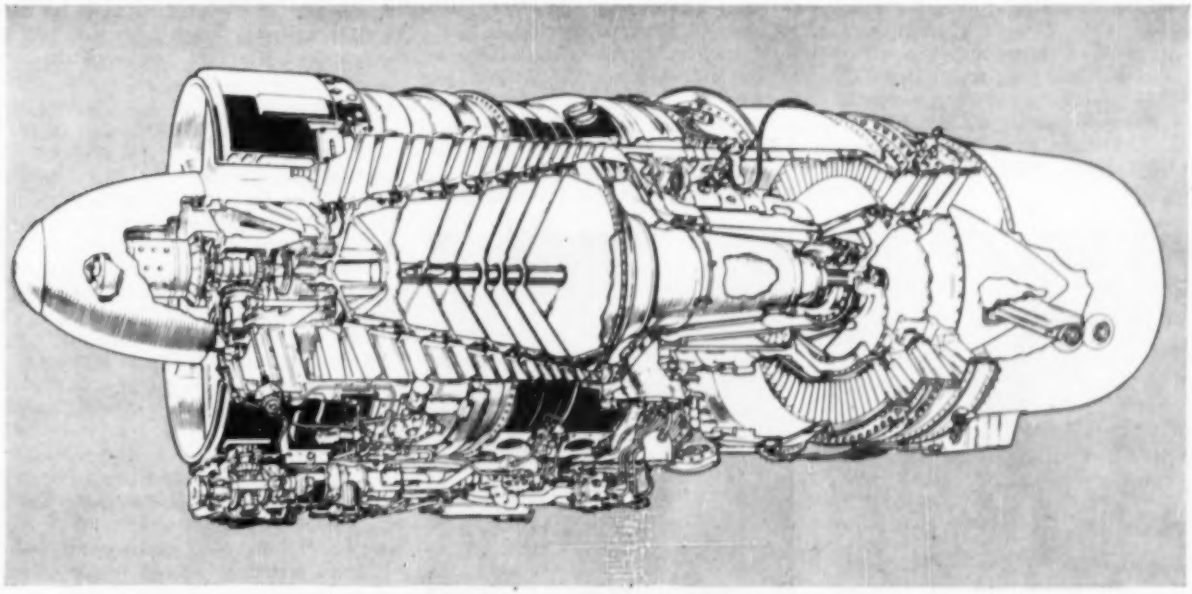
• **Defense Department ordered a cut** in progress payments. Effective Sept. 1, percentage allowed will be 70% of total costs incurred by contractors instead of 75% or 85% of the cost incurred for direct labor and material, exclusive of overhead, instead of the former 90%. Old contracts as well as new will be affected. No specific exemption for ballistic missile contractors was included in the directive (7800.5), but the directive leaves room for negotiation on most contracts. In an attempt to assist small suppliers, the directive exempts them, allowing contracting officers to provide "so long as reasonably necessary" payment of up to 75% of total costs or 90% of costs of direct labor and material.

• **Subcontracting policy.** Air Materiel Command said policy remains the same so far as percentage of total business that USAF tries to give to subcontractors, but that the percentage is harder to control in a period of contraction. In the past, the goal has been 40 to 50% of the dollars spent on a weapon system. AMC now is trying to hold the actual figure to between 30 and 40%.

• **Contract maintenance.** Gen. E. W. Rawlings, AMC commander, told AVIATION WEEK the basic policy has not changed on this either but that USAF must keep the amount of contractor maintenance under control. USAF originated the idea but found that when it reached a level it wanted to hold, contractors wanted even more expansion.

In the past, USAF has had enough second line aircraft to let more than half its maintenance be done by contract. Now, as the advent of missiles and the effect of economy waves force it to eliminate some second line aircraft, contractor maintenance is bound to decline. Gen. Rawlings pointed out, however, that USAF maintenance is dropping, too. Maintenance depots have been closed in Alaska and Hawaii and plans for three others, including one in Spain, have been scrapped. Existing depots will be modernized wherever necessary to handle new equipment, but this is not considered expansion. Depot manpower now is 25,000 to 30,000 below the Korean war peak.

• **Navy says it will reduce** civilian jobs by 18,000 in this country and abroad during Fiscal 1958. A spokesman said most of the reduction will be accomplished by Oct. 31, partly through attrition, Navy said.



Cutaway Shows Gyron Details

Cutaway of 20,000 lb. dry-thrust Gyron shows that the simple single-spool layout with its short, all stainless steel seven-stage compressor. The trumpet-shaped sheet metal shaft joining the compressor with the turbine provides sufficient stiffness so the usual third bearing at shaft mid-point can be eliminated, de Havilland said. Two turbine stages have blades of fully machined Nimonic forgings using fir tree attachments. Engine is designed for extended supersonic flight.

BUOYANCY of new flight suit and boots is demonstrated in a San Diego swimming pool.

Safer, More Comfortable Suit Developed for Supersonic Flight

Light-weight flying suit, based on the partial pressure concept and designed to cover the flight profiles of USAF's supersonic fighters, interceptors and bombers, has been developed for the Air Force by a subcommittee of the Industry Crew Escape Systems Committee. New flight gear will give supersonic pilots greater safety, more mobility and increased comfort.

Convair-San Diego's Human Engineering Group functions as chairman of the ICESC subcommittee on development of personal equipment. ICESC is composed of 13 major aircraft companies working cooperatively on pilot escape system problems (AW May 6, p. 94).

The new garment, which is being developed by Convair's Human Engineering Group under guidance of the Aero Medical Laboratory, Wright Air Development Center and the ICESC subcommittee, is made up of an improved helmet, boots and gloves which are integrated into a flight suit.

Convair attributes these advantages to the new flight suit:

- **Combines** into one three-piece outfit the five separate garments now required for survival: waterproofing; thermal liner for warmth; ventilating suit for cooling; partial pressure suit, and underwear.
- **Provides** up to 10 seconds additional protection against burns.
- **Floats** a pilot face up—even if unconscious—with full gear and in cold water without undue exposure.
- **Decreases** bulk of the equipment, giving it greater comfort and reducing drag during a supersonic ejection.
- **Reduces** by about one third the time it now takes a pilot to don the full complement of personal equipment, an important consideration in case of a sudden enemy air attack.

Here is what Convair engineers did to give a pilot more mobility while his body is under pressure and more comfort during the 99% of the time his suit is unpressurized:

- **Helmet** has a larger face plate for increased visibility, is structurally stronger to withstand supersonic ejection blast, yet is less bulky and is lighter in weight than the MA-2 and MA-3 types in use.
- **Seal at the neck** incorporates a ball bearing between helmet and suit, allowing a pilot to turn his head easily at 90 deg. in either direction. All communications, oxygen, electrical and ventilation lines leading from cockpit to suit enter the helmet through one anchor point. This is a big improvement, according to Convair, because few men are strong enough to turn their heads appreciably while under pressure in the present MA-2 or MA-3 helmets.
- **Gloves** are made in two parts. One part is fingerless and pressurizes the back of the hand. Second part covers the fingers, but without pressurization. Convair says tests have shown that, if the fingers are not enclosed in the pressurized portion of the glove, pilot's hands do not lose mobility and dexterity as happens with present equipment.
- **Boots are sized** to the pilot's feet with nylon lacings and are closed by a zipper. To put them on, a pilot simply laces the boots to size and zips them closed. Feature of the boots, which were made for ICESC by Chippewa of Wisconsin, is that they float, which helps a pilot to remain afloat and warm and makes it unnecessary for him to take them off in the water.

New suit has been tested exhaustively for pressure in an altitude chamber at Randolph Air Force Base, Tex.; for wind blast and deceleration stresses at USAF's SMART track at Hurricane Mesa, Utah; for fire resistance at Convair-San Diego, and for immersion in a San Diego swimming pool.

Convair concedes that the new suit is "not so much a new design as a redesign, and it is still based on the partial pressure concept."

Other companies working on the ICESC personnel equipment subcommittee with Convair include: Boeing Airplane Co.; Convair-Fort Worth; Lockheed Aircraft Corp.; North American Aviation, Inc. and Republic Aviation Corp. Naval aero-medical officers from North Island Naval Air Station, San Diego, sit in as observers.

COMPACTNESS of new suit is evident (left). Convair tool builders tailor new suit (right).

Greater Human Factors Emphasis Asked by Navy Safety Expert

By Richard Sweeney

San Diego—Cockpit instrumentation today is designed for everything but the man who is flying the plane, a Naval safety expert told Institute of Aeronautical Sciences members meeting here last week.

Accidents often attributed to pilot error really are failures of instruments, according to Capt. J. Sinkankas, aviation safety officer of staff commander, Air Force Pacific Fleet.

Capt. Sinkankas presented a paper at one of two open sessions among the five at the IAS National Naval Aviation meeting. The session was highlighted by discussion of the need for human factors consideration in all aspects of weapon systems throughout their evolution and use.

Cockpit Problems

The safety officer cited these problems in present cockpit instrumentation:

- **Today's attitude indicator** is small, yet this is the most vital instrument and should be at the center of attention and easiest to read, with all other gauges grouped and designed to be complementary.

How about a rectangular presentation with proper color for earth and sky?, he asked.

- **Noise in the airplane** from many sources has been dampened, but the loudest and most irritating noise, that through the headset, still is an annoying factor. He asked if it might not be better to delay more avionic advances in this area and concentrate on solving this bugaboo.
- **Altimeter at present,** with its three hands, presents a problem. Misreading is too frequent and disastrous, and inaccuracies are well recognized.
- **In personal equipment,** a part of today's high performance airplane cockpit environment, the pressure suit is highly uncomfortable and almost immobilizes pilots under normal circumstances, let alone when an emergency demands its use in pressurized configuration.

Result of today's instrumentation displays and cockpit environment, is that accidents frequently attributed to pilot error really are failure of instruments, Sinkankas declared. Pilot problems resulting from today's cockpits and presentations are mostly mental rather than purely physical ones, he said.

Other sections of the weapon systems which need closer human engineering from the very beginning, the paper indicated, are those parts which affect maintenance and manufacture. Designs should be keyed to what service personnel can maintain without strain, which in turn leads to maintenance problems and sometimes to accidents. Systems need design and engineering aimed at the ultimate in upkeep if complete advantage is to be taken of the advanced capabilities they embody, according to the paper.

Also, Sinkankas said, experience has shown that, while it is the older, experienced pilots who sit in judgment on new aircraft in test, it is the younger, less mature pilots who fly them and incur high accident rates.

In these cases, the paper pointed out, the older, more mature pilots have learned through experience to live with undesirable characteristics of airplanes, to compensate for them automatically, and, hence, those characteristics which can hamper fleet operations by younger pilots pass through test phases without correction, showing up in operational accident rates.

Another factor bearing on the situation is that techniques once accepted operationally tend to be used again. Sinkankas said this is especially true in pilot training. The proven methods of yesterday are supposedly adapted to newer planes, and perhaps this area bears investigation leading toward improvements along the line, so that old techniques which are not necessarily the best ones, can be weeded out and new ones substituted.

Warfare Analysis

Concerning warfare problem analysis, a paper prepared and delivered by F. Gloeckler, director of the Air Warfare Research Department, Air Development and Materiel Center, said one of the most necessary portions of such work is being sensitive to changes in original assumptions upon which weapon systems for a given combat condition are based.

For best results, analysts should always be willing to review original assumptions and change them according to new developments on new information. Accuracy of assumptions should always be questioned rather than accepted as unchanging facts, the paper said.

Another factor bearing close scrutiny is realism of weapon system requirements in terms of time rather than mission. In an original analysis which called for development of a very sophisticated weapon system to meet the conditions, it is a waste of time to specify a degree of sophistication which can be reached eventually. The paper said such capabilities are desirable as can be built with reliability in the same time period in which the other components of the weapon system are to function.

Sophisticated abilities reaching operational reliability and production status in an obsolete airframe are to be avoided, the paper indicated.

Fatigue Failures

Judging of safe service life for high performance aircraft in terms of possible fatigue failures calls for accurate determination of load and structural integrity as early in the plane's life as possible, according to a paper prepared and read by C. P. Baum, of the Airframe Design Division of Navy's Bureau of Aeronautics.

Today's structures of heavy plates and forgings have indicated, Baum said, that complete failure follows swiftly after first cracks appear, making it imperative that accurate as possible knowledge be obtained as to when the plane's service life is nearly over and its structure is entering the time period when possible overloads may induce sudden and complete failures.

He cautioned, however, that too great a conservatism in forecasting a correct service life for a design can cause trouble in the too early retirement of very expensive weapon systems while operational capability remains within safe operating margins.

Characteristic of today's loads, Baum's paper indicated, are low cycle, number and high load factors.

Affecting this in turn are changes in mission the plane was not originally designed to accomplish, unexpected usage which induces loads near the limit load factor more frequently than was anticipated in original design specifications.

Navy Program

In its current program to insure an economical yet safe service life for its aircraft, Navy has eight-channel oscillographs and statistical accelerometers mounted in at least 200 of the 20 latest types aircraft in use.

Role of flight safety engineering encompasses almost every aspect of aircraft design and test, C. O. Miller, Chance-Vought Aircraft staff engineer, said in his paper. Incorporation of safety engineering occurs all along the airplane's development cycle, from design board through test flight and operational use.

Miller said flight safety engineering should have a high position within the company operating framework, with its activities spread downward through the various working levels and groups with an engineering flight test and field service.

Pratt & Whitney Says Cutbacks Peril Nuclear Engine Project

Washington—Pratt & Whitney Division of United Aircraft Corp. told its stockholders last week it is "probable" that its nuclear aircraft engine project "will be drastically reduced in scope or even possibly eliminated entirely."

Air Force refused to say what its investment in the Pratt & Whitney project is thus far but confirmed that the aircraft nuclear propulsion program as a whole is under intensive review, and said a decision is imminent on how much development to continue to support.

One likelihood is that USAF will cancel its support of the Pratt & Whitney project, but that the Atomic Energy Commission will continue to support it. Air Force is building the Connecticut Aircraft Nuclear Engine Laboratory at Middletown. Pratt & Whitney is scheduled to use it for research and development under contract to both USAF and AEC.

But if USAF, the major backer in terms of dollars, should decide to abandon this project and continue to support only the General Electric Co. project at Evendale, Ohio, and Idaho Falls, Idaho, Pratt & Whitney might conceivably decide not to continue the work at such a low level of support.

Pratt & Whitney pointed out that any change in the status of its nuclear project, "if it comes, will have little effect on current operating results or those for the future, as it has never been counted on materially in our financial forecasting due to its highly experimental nature and nebulous production potential. All capital assets devoted to this particular project have been furnished by the government."

Stopping of development work on the T57 turboprop engine also was reported by P&W, due to Air Force's cancellation of the Douglas C-132 cargo project. The company said work on the T57 "could be quickly resumed if a requirement for such an engine developed in the future," because development work on the J57 turbojet version is continuing.

The company said possibility of a change in the status of the nuclear engine project was due to "the Defense Department economy drive in combination with the rapid advances being made in other forms of aerial propulsion."

Future of airframe projects for the nuclear powered aircraft also are in doubt. Lockheed Aircraft Corp. this year has carried on its weapon system contract on the nuclear plane with about one third as many engineers as last year. Slowdown means that the laboratory being built in North Georgia would come into operation some 16 months later than it could have. Lockheed and Pratt & Whitney are teamed on one airframe-engine concept and Convair Division of General Dynamics Corp. is teamed with General Electric on a second concept.

The Convair-GE program also is continuing at a lower dollar volume and longer time phasing.

Rocket-Jet Fighter

Saunders Roe Ltd. was awarded preproduction contract for mixed rocket jet interceptor developed from its SR.53 research aircraft. Mach 2 fighter is to be known as Saunders Roe P.177. Contract is similar to preproduction contract which was placed with English Electric for 20 P.1 fighters, but is only for eight aircraft. Powerplants will be de Havilland Gyron Junior with afterburner and de Havilland Spectre variable thrust rocket engine.

Future of Saunders Roe contract is uncertain in view of white paper cutback and the fact that English Electric P.1, which Defense Minister Duncan Sandys called last of Britain's manned fighters, also can be equipped with rocket power. Future development of P.1 as mixed interceptor will be with external fuselage podded Napier Scorpion rocket engine. Development of this combination is already well along.

Smith Leaves Slick, Replaced by Rentzel

Dallas—Robert J. Smith resigned as president of Slick Airways last week, with Delos W. Rentzel again becoming operating head of the cargo airline.

Smith resigned his positions of president, director and member of Slick's executive committee, severing all relations with the airline. Reason cited by Rentzel in announcing the change was that Smith is engaged in a number of other activities and finds he cannot do justice to them and to Slick.

With Smith's resignation, Rentzel resumes the duties of president he dropped when Smith joined the airline in May, 1956. Rentzel joined Slick as chairman of the board of directors in November, 1954, and served as chairman and president during the period when the carrier was rebuilding after the planned merger with Flying Tiger fell through. Rentzel remained as chairman when Smith took over the presidency last year.

Before joining Slick, Smith was involved in a number of activities, including duties as board chairman of the Eleventh Federal Reserve Bank and president of Pioneer Aeronautical Services and Pioneer Air Lines. He continued his association with the Federal Reserve Bank and Pioneer Aeronautical during his tenure with Slick. Smith is also a USAF Reserve brigadier general.

Rentzel said Smith came to Slick with the understanding that he would continue active participation in all these affairs. After trying it for a year, Rentzel said, Smith finds "it is not feasible for one man to do justice to all of these important activities."

"While we understand his devotion to these earlier interests," Rentzel said, "we deeply regret that he has elected to resign from Slick. Under his direction, the company was successful in obtaining additional financing needed to continue the expansion of its aircraft fleet. This equipment allowed the company to increase its international operations and to improve its domestic common carrier service."

News Digest

Boeing Airplane Co. has been awarded a $139,315,444 Air Force contract for production of the IM-99 Bomarc interceptor missile. USAF will use the Bomarc for area defense.

Daniel G. Mazur, Naval Research Laboratory specialist in design and operation rocket telemetering, was named last week as manager of the Vanguard Operations Group at Patrick AFB, Fla. Mazur, an electronics engineer with NRL since 1946, will supervise the Navy's part of the operations at Patrick for the earth satellite program.

Brig. Gen. Victor Haugen has been named assistant deputy commander of the Air Research and Development Command for Weapons Systems with headquarters at Wright Air Development Center, Dayton. He succeeds Maj. Gen. Howell Estes who moves to the Pentagon as assistant USAF chief of staff for air defense systems.

Doman LZ-5 helicopter is being demonstrated to Gulf Coast oil companies in a 4,000 mi. tour. Only spare parts carried are spark plugs.

Bell Aircraft Corp. acquired Birma Manufacturing Co. of Buffalo, N. Y., a producer of molded Fiberglas products. Transaction, including cash and shares of Bell stock, makes Birma Bell's seventh wholly owned subsidiary.

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CAA Says Jet Airliner Problems Ease

Second jet age planning report is issued by CAA in effort to put jet problems in proper perspective.

By Ford Eastman

Washington – Problems expected through the use of jet aircraft in civil air transportation will not be as serious as first thought, the Civil Aeronautics Administration reported today.

In its second jet age planning progress report, the CAA said intensive study of jet operational requirements has reduced many jet problems to their proper perspective, dispelling much of the earlier concerns. The agency's first jet progress report was issued last year (AW July 16, p. 27).

The CAA said that, in the past, "various quarters" have expressed concern over such questions as runway length and strength requirements, foreign object damage, jet fuel reserves, slow recovery to full thrust and noise. Now, runway problems concerning length and strength appear to be of minimum concern in instances where the jets will fly the same route structures as today's larger piston-engine aircraft. Runway length increases, however, probably will be required for turbojet aircraft that will fly ranges in excess of those presently accommodated, the CAA said.

Foreign Object Damage

Foreign object damage of jet engines has been a serious problem in past military operations, the report said, but added that improvements in compressor and intake designs of civil jet transports, plus potential developments such as the aerodynamic screen and good housekeeping of ramps and taxiways are now considered satisfactory to handle this problem.

In the case of fuel reserve, the report pointed out, experience with military jet operations where short fuel reserves were encountered were misleading when applied to civil jet operations. The civil jet manufacturers, it said, have used great care in designing the jet transports to have holding fuel reserves and general terminal performance comparable to present civil practice.

As for recovery of full thrust on approach, the CAA said the twin spool and variable stator jet engines have shown the ability to have recovery times essentially comparable to present, large piston engines.

Another problem expected with the jet engines was that of reverse thrust for braking. Here again, the CAA said, the problem has been reduced through the development of reverse thrust devices.

Because of the public concern over jet aircraft noise, the CAA placed special emphasis upon the noise problem. Public concern was based primarily upon the noise of military aircraft—the sonic boom, jet afterburners and noise at takeoff.

Since civil jet transports will not go faster than the speed of sound, the sonic boom will be an exclusive phenomenon of the military. CAA also pointed out the jet afterburner also is an exclusive military feature which will not be used on civil jet transports. As for takeoff noise, the agency said, all civil jet transports are to be equipped with suppressors mounted on the exhaust of the engines. The report predicts that these suppressors will reduce the noise of the jet transports to approximately that of present, large piston-engine aircraft.

The CAA jet planning program was initiated one and a half years ago to provide the maximum information possible to ease the transition from piston-engine aircraft to jets. Both government and industry are participating. The program has been aided substantially, the CAA said, by manufacturers of jet and turboprop aircraft through special jet planning conferences and provision of considerable technical information. The military also has contributed through providing background on jet operational experience.

Report Highlights

Basic material for the current report was provided by the CAA offices of Flight Operations and Airworthiness, Airports, Air Traffic Control, Air Navigation Facilities and Planning Development. Other highlights are:

• **U.S. turbine** transport production. Current schedule calls for two large jet transports by Jan. 1, 1959; 31 by July 1, 1959; 122 by Jan. 1, 1960; 215 by July 1, 1960; 365 by Jan. 1, 1961, and 466 by July 1, 1961. Because of export sales, not all of these aircraft will appear in the U.S. It is estimated, however, that 272 transports will be operated by U.S. carriers by 1961, plus any foreign jet aircraft sold in the U.S.

• **Passenger capacity** of U.S. jet transports. In designing the jets, emphasis has been placed upon flexibility of interior arrangement by use of seat rails, movable lights and air units, suitable location of exits, buffets and washrooms. Thus, the aircraft can be adapted to a wide variety of passenger and cargo arrangements. The capacity range of large U.S. jets which are applicants for CAA type certificates is: standard-first class, 80 to 118 passengers; coach, 108 to 179, and high density-maximum, 142 to 219.

• **Performance standards** and runway lengths. Turbine engine is more sensitive to the effects of temperature variation than the piston engine, and, therefore, a more accurate account must be taken in establishing the relationship of turbine-powered aircraft weights to the runway lengths, climbout path and other related factors. For a 10 degree increase in temperature, the piston engine loses 1% in power, the jet engine loses 3% and the turboprop engine loses 4 to 5%. These variations may be changed substantially by other factors. For example, water-alcohol injection may be used in a turboprop engine to maintain power up to high ambient temperature conditions. Water augmentation may be used in jet engines to maintain standard temperature thrust to elevated temperatures.

• **Cross-wind landing.** The jet transports employ swept wings that are more sensitive to the effects of cross winds in that there is a greater tendency for the aircraft to roll laterally. To compensate for this, much more powerful lateral control devices such as differential use of spoilers are being incorporated. While most current transports are certificated to a 20 and 30 mph. cross wind, maximum cross wind values of 30 mph. to 35 kt. are being proposed for the jets.

• **Fuel.** No decision on a single type of fuel for civil turbine engines has been reached although U.S. airlines generally have expressed a preference for kerosene, primarily on a density and cost basis.

• **Fuel dumping.** The elapsed time for dumping fuel on present piston-engine aircraft is about 15 minutes maximum. However, jet aircraft, with much greater fuel quantities for long-range operations, may require up to 40 minutes. A further problem in fuel dumping from jet transports arises with kerosene base fuels. These fuels have a lower volatility than current aviation gasoline and may require greater care in the selection of dumping altitudes and locations.

Eastern Wins Nonstop Route Between New York, Mexico City

Washington—Designation of Eastern Airlines as the U.S. carrier to operate nonstop service between New York, Washington and Mexico City was approved last week by President Eisenhower. The Civil Aeronautics Board had recommended Eastern over Pan American World Airways by a three to two vote.

Under the bilateral air agreement with Mexico, Eastern's authorization will terminate June 30, 1959.

Eastern hopes to begin service within the next 30 days if "the necessary international formalities can be expedited," Board Chairman E. V. Rickenbacker said.

Rickenbacker praised the Board's "crystal clear concept of the issues involved" and its "staunch defense of the public interest and needs."

The airline will use DC-7B "Golden Falcon" aircraft for first class service on the route, also provide coach service, probably with Super C Constellations.

Mexico has designated Aeronaves de Mexico to compete with the U.S. carrier on the New York, Washington-Mexico City route. Its application for a foreign air carrier permit has been approved by CAB Examiner Francis W. Brown, leaving only the Board and the President to take final action.

Designation of Eastern and Aeronaves de Mexico by the two countries is a double blow to Pan American. Not only did the airline lose out in its own bid to serve Mexico from New York and Washington, but it now must divest itself of all stock interest in Aeronaves de Mexico. Pan American interest in Aeronaves was permitted by the CAB until such a time as the Mexican airline inaugurated service beyond the border of Mexico.

In support of the majority opinion granting the route to Eastern, CAB members Harmar Denny and G. Joseph Minetti said the market to be served is primarily tourist and therefore Eastern's proposed "turn-around" flights would best meet tourist needs and would attract the greatest potential traffic. Denny and Minetti added that Eastern's experience in developing the New York-Florida tourist traffic would serve the airline well on its new route.

The Board pointed out that the choice of Eastern also was based on the fact that for more than 10 years the carrier has held authorization for one-stop service in the same market via New Orleans. However, it lacked permission from the Mexican government to implement service on that route until last month.

The CAB majority said the evidence in the case indicated that Pan American's proposed operation would not be a fully profitable one, much less produce sufficient profits to offset subsidy. The three members said Pan American proposed only through flights between Mexico City and Europe via Washington and New York, and that, while these schedules would be attractive to travellers between Mexico and Europe, these travellers would account for only 3.6% of the total moving over the Mexico City-New York route. At the same time, they said, the bulk of the traffic would be obtaining less convenient and dependable service than that which Eastern proposed.

The minority, members Chan Gurney and Louis J. Hector, said the market in question is now largely served by foreign operators and that a U.S. airline with foreign operating experience is best qualified to capture a large portion of it. They called attention to Pan American's plans for mixed tourist and first class service aboard the same plane. Eastern, they said, only plans first class service from New York and tourist service from Washington.

"Furthermore," the minority added, "Pan-American would provide one-carrier service to Latin American cities beyond Mexico City, thus increasing traffic and the utility of the route to passengers."

They also said that it is a mistake to assume that Eastern would generate more use of the new service than Pan American.

Meanwhile, a decision as to whether American Airlines or Braniff International Airways should be designated to operate nonstop service from Chicago to Mexico City is pending before the CAB. Compania Mexicana de Aviacion has been designated for the same route by Mexico. Its foreign air carrier permit was approved by the President last week.

Tax Writeoff Benefits Restricted

Washington—Rapid five-year tax writeoff benefits will be denied airlines under congressional legislation passed last week.

The measure will also bar the tax benefit for facilities for commercial aircraft production and sharply curtail the area of defense facilities eligible. At present, the tax benefit may be awarded under the loose criterion of "national defense." Under the new measure, rapid amortization certificates would be limited to two types of defense facilities —research, developmental or experimental on the one hand and facilities to produce "new or specialized defense items" on the other.

Another civil aviation measure was sent to the White House for the President's signature. The legislation would award permanent certificates to U.S.-Alaska carriers. Other measures acted on in the closing days of this session included:

• **Guaranteed loans.** The Senate by an overwhelming 72 to 9 vote approved a measure authorizing the Civil Aeronautics Board to approve government guaranty of loans to local service carriers to finance new equipment purchases. Two Alaska carriers—Alaska Airlines and Pacific Airlines—and two Caribbean carriers—Caribbean Atlantic Airlines and Mackey Airlines—also would be eligible. The House is expected to approve a similar measure this week. In addition to the local service, Alaskan and Caribbean carriers, this measure also would authorize the guaranty to the local helicopter operators, Chicago Helicopter Airways, Los Angeles Airways and New York Airways.

• **Capital gains.** Legislation authorizing subsidized carriers to set aside earnings from equipment sales for new equipment purchases is expected to clear the Senate.

• **Reequipment financing.** Another measure to facilitate the reequipment financing of airlines is also expected to pass this session. This would encourage financial institutions to offer financing by granting them rights over the equipment financed in case of bankruptcy. Senate Judiciary Committee opened hearings last week. House Judiciary already has approved the measure.

• **Alcoholic beverages.** Senate Commerce Committee opened hearings last week on legislation banning the consumption of alcohol on commercial or military aircraft, but it appears unlikely that the measure will be brought up for floor action before adjournment. Last year, the House approved the anti-alcohol measure.

• **Postage increase.** Legislation boosting the airmail postage rate from six to seven cents an ounce was approved last week by the House but is expected to be shelved by the Senate Post Office Committee.

Convair-Eland Sale

London—Conversion of three Convair 340 airliners with Napier Eland turboprop engines has been ordered by REAL Airlines of Brazil. Conversion will be done by Pacaero Engineering Corp., at Santa Monica, Calif.

Russia Turns Attention to Feederlines

Moscow—Russia has begun to pay some badly-needed attention to its neglected feederlines.

With the USSR parading a whole family of new turboprop and turbojet transports for its international and domestic trunklines (AW July 22, p. 26; Aug. 12, p. 40), Aeroflot's vast network of local routes has been doing business as usual with the world's largest fleet of outmoded commercial aircraft. But things should begin improving equipment-wise for the Soviet feeders next summer.

Main factor is that O. K. Antonov, designer of the new Ukraina four-turboprop transport, is once again using his talents in behalf of the local carriers. His Pchelka (Little Bee) twin-engine transport is expected to be ready for regular short-haul airline service by next summer. One version of this feederliner will carry six passengers in two tandem rows.

The An-14 Little Bee, with its 143 mph. top speed, will be faster than any of the Soviet aircraft now used widely by the local carriers. Its ability to take-off and land in 135-195 ft. will be invaluable for operation into the primitive airfields that mark nearly all intermediate points on Russia's feeder routes.

Present Equipment

At present, Aeroflot largely depends on three aircraft types to provide local service: the Po-2, Yak-12 and An-2.

The Po-2, first flown as a trainer in 1927, is a single-engine, open-cockpit biplane with a top speed of under 100 mph. Since 1934, when the 17th Communist Party Congress directed Aeroflot to organize and expand local airline service, the rugged Po-2 has been officially recognized as the Soviet feeders' "basic" aircraft.

The single-engine Antonov An-2 biplane—a postwar development—has been the local carriers' heavy-duty workhorse during recent years. Capable of carrying 10 passengers in hard seats or over 2,600 lb. of cargo, the An-2 is also adept at operating from small, unimproved fields.

Newest of the Russian feederline aircraft is the four-place, single-engine Yak-12M lightplane.

Complaints from Soviet feeder officials over the inadequacies of their present short-haul fleet have multiplied during the past two years as the gap between the quality of Russian trunkline and local services widened. Loudest demand was for a plane smaller than the An-2 but with a capacity and range considerably larger than the Yak-12's.

Among the top Soviet designers, Oleg Antonov, who started his career as a glider builder, showed the most interest in the feederlines' equipment problems. His request to develop a new short-haul transport was approved in 1956. The Little Bee, to be tested this fall, is the result.

What Feeders Want

With the advent of the Little Bee, Russian feederline managers have high hopes for other major improvements in local service—better navigational aids, more paved runways and modern terminal facilities. They also want a fleet of planes that can be counted upon the year around.

Every summer, large numbers of Russia's local airline planes are diverted from passenger-mail-cargo service to agricultural work, with a resulting disruption of schedules. This practice dates back to the time before 1934 when the local carriers were branches of Soviet agricultural aviation.

Aeroflot's management also is unhappy over the low plane utilization and load factors for the local airlines' An-2s. Poor communications and navigational aids hurt service regularity. Accidents, allegedly caused by "undisciplined pilots who ignore weather conditions," have caused much concern.

An overhaul of the local route structure is also in the works. Aeroflot admits that the network has grown haphazardly and not on area need basis.

"The time has come for local and inter-province airlines to develop not blindfolded but on the basis of a thorough study of regional economics," Aeroflot organ "Grazhdanskaya Aviatsiya" declared recently. "We must turn the attention of the economists in our subdivisions from bookish planning and paper statistics to the facts of life."

Aeroflot has good reason to be concerned about its local service, since it accounts for an important share of the Soviet monopoly total traffic. In 1956, Russian local carriers handled 40.3% of Aeroflot's passengers, 36.3% of the mail and 29.5% of the cargo.

As early as 1940, Russia's local airline system covered 80,625 kilometers and passengers totaled 73,946, according to Soviet statistics. In the past five years alone, 20,000 kilometers of local routes were opened.

From the standpoint of route mileage, the Soviet feederline network appears to be the largest in the world, although traffic on many links is thin.

It is estimated that Russian local carriers boarded 800,000 passengers and flew about 19 million ton-miles last year. By comparison, U.S. feederlines handled 3,453,000 passengers and flew 66.5 million revenue ton-miles in 1956.

Passenger Growth

During the Fifth Five-year Plan (1951-1955), Soviet feeders reportedly increased their passenger business by 70%. Last year, with the opening of new routes, acquisition of more planes and the cutting of many fares, local passenger traffic jumped 60.3%, cargo 49.5%, and mail 15.7% over 1955.

Recent feeder service expansion has been spectacular in several areas of Russia. In Kostroma province, there were four local air routes which handled only 400 passengers in the last quarter of 1955. In the final quarter of 1956, the province had 13 local air routes and 10,700 passengers.

In some respects, Russia's local airlines performed a more vital function than their American counterparts. Many of the points served have neither automobile nor railroad transportation, the latter frequently being several hundred miles away.

Routes are usually hinged on a provincial center and branch out to the district centers. Until recently, mail rather than passenger convenience was the principal factor in scheduling.

Under the Sixth Five-year Plan (1956-1960), development of passenger traffic has received top feederline priority. Customers, however, need little encouragement to flock to such local routes as that between Krasnodar and Maikop in the Northern Caucasus, where air time is 90 minutes and train time nearly three days.

RUSSIAN Pchelka (Little Bee) transport will serve local carriers in USSR.

Flameouts Trouble RAF Comets; Modification Program Under Way

By William J. Coughlin

London—De Havilland Comets IIs now in operational service have encountered a series of flameouts of their Rolls-Royce Avon Mk. 117 engines under tropical flight conditions.

Early difficulties were traced to icing in the fuel system, now cured by a change in operating procedures. Since then, however, there have been flameouts in turbulence similar to those encountered by early versions of the Hawker Hunter when firing their guns.

A modification program, including both ground and flight testing, is under way at Rolls-Royce and de Havilland in an effort to solve the trouble. Flameouts and compressor surging first were encountered by a Comet II of Royal Air Force Transport Command on a flight through a severe tropical front above the Bay of Bengal.

Transport Command, which has taken delivery of ten Comet IIs, currently is operating an airline schedule between England and Australia, through Tobruk, Bahrein, Colombo and Singapore.

Turbulent Area

The later trouble occurred on a Comet which entered an area of severe turbulence above 40,000 ft. Two of its engines flamed out while rpm. on the remaining two dropped off due to compressor surging. The aircraft descended to 35,000 ft. where, on the third attempt, the pilot succeeded in relighting the two engines while still flying in cumulo-nimbus.

The trouble is attributed to sharply disturbed flow across the intake at high incidence, resulting from the peculiarly rough conditions of the inter-tropical front.

Following the Bay of Bengal incident, de Havilland test pilot John Cunningham took a Comet II to altitude over England and put it through a series of violent maneuvers in an effort to reproduce the pattern of the flameouts. They did not recur.

A Comet II, with de Havilland and Rolls-Royce engineers aboard, then was flown to the area where the trouble first was encountered. The aircraft deliberately entered the frontal thunderstorms seeking to duplicate the exact conditions of the first incident.

The experiment was successful—almost too much so, according to technicians who went through the violent gusts which at times exceeded 4Gs.

The result was one flameout and a serious case of surging on another engine. It was determined that the difficulties occurred above 40,000-ft. at 7,550 rpm. at Mach .76—slightly above the Mach .73 normal cruising speed for the Comet II.

Transport Command is operating the Comets under a full civil certificate of airworthiness at heights up to 45,000 ft. If it should lose its civil certificate for any reason, the Comet would immediately be withdrawn from passenger service by the RAF.

Rolls-Royce reports that the trouble can be avoided by reducing rpm. to 7,000 and speed to Mach .65. This is its recommendation to Comet pilots entering such weather fronts.

"The immediate urgency is resolved by following these operating conditions," says a spokesman for the engine firm, "and the next step is to see what can be done to cure the trouble."

Modification now being flight tested involves varying the setting of the variable-incidence compressor inlet guide vanes.

The guide vanes were designed for maximum incidence at low engine speeds and zero incidence at high engine speeds, producing a minimum of swirl. They are operated by a ram on the lower right-hand side of the compressor casing. Within the operating range of the guide vanes, the ram position is related to engine speed by a governor pump. The ram moves to the rear as rpm. increases and opens the vanes to reduce the swirl and increase the airflow. The modification, varying the operating range of the vanes, reduces mass flow slightly but it is hoped that it will cure the flameout trouble.

The modification has been flight tested in England but not in the Bay of Bengal area as yet.

Plans also are under way to test the de Havilland Comet IIE in the inter-tropical front to determine whether similar difficulties occur with its Rolls-Royce R.A. 29 Avon engines. British Overseas Airways Corp. has taken delivery of the first of its Comet IIE's which are to be used to gain experience on the engine which will power the Comet IV.

New Series

On the IIE, two of the R.A. 29s are mounted in the outboard position with intakes modified to provide sufficient flow for the more powerful engines. Rolls-Royce engineers do not expect a duplication of the flameouts, noting that the 200 series is considerably more advanced than the basic 100 series Avon.

The flameouts occurring in the inter-tropical front were the second series of flameouts encountered after the de Havilland Comets were placed in service by Transport Command.

When the aircraft began operating on the route to Australia, icing problems developed. On occasion, two engines at once flamed out—sometimes in clear weather. In all cases, the engines were relighted successfully at altitude and no aircraft had to land with a dead engine.

The trouble was traced to fuel filter icing, producing flameouts from extremely low fuel temperatures. This was solved by changing the procedure in use of the filter heater. Previously, the switch, activated from the cockpit when icing was noted, was spring-loaded to shut off after a minute. A red warning light indicated when flow through the

BOAC Britannia 312 Flies

Second production Britannia 312 of 18 on order by British Overseas Airways Corp. makes its first flight at Filton. Howard Hughes reportedly is negotiating to buy Britannias, but BOAC has balked at giving up half its 312 order as Hughes is seeking. Total Hughes order for TWA would be 22-25 aircraft.

filter was reduced. Now, when fuel temperature reaches zero, the heater is turned on and left on. For greater accuracy, fuel temperature bulbs have been shifted closer to the engine at the low pressure filter valve.

To offset the slight increase in fuel consumption caused by leaving the heater on, Transport Command has increased its inflight fuel reserve from 6.5% to 8%.

Transport Command states that from the maintenance standpoint it is well pleased with the performance of the Rolls-Royce engines. In some 24,000 engine hours, there have been only four unscheduled engine changes.

The RAF Comets are fitted with Ekco nose radar and the command regards this as "absolutely essential" to operation on the Australian route in view of the troubles encountered. Simplest solution to the flameout problems is keeping out of the severe and unusual weather conditions where they occur and the storm-warning radar makes this possible.

The modification program being carried out by Rolls-Royce and de Havilland is not considered extremely urgent since RAF has no further Comet IIs on order and a limited number of engines therefore are involved. The engine itself, of course, is one of the earlier Avons.

CAB Fare Probe to Investigate Earnings vs. Jet Financing Needs

Washington—Effect of current fare levels and earnings upon airlines' ability to attract financing for new jets will receive priority when the General Passenger Fare Investigation is resumed on Nov. 18, according to the Civil Aeronautics Board.

The decision to review airlines' reequipment and financing programs came shortly after the Board had turned down a bid by airlines for a 6% passenger fare increase as an emergency measure to meet rising costs and dwindling profits (AW Aug. 12, p. 38).

The CAB said that, while it had voted to deny an immediate 6% increase in fares, it recognized the importance of an early review of the domestic trunkline fare level for the entire domestic trunkline system and not merely for the seven carriers that sought the emergency fare boost. As a result, the CAB ordered that the General Passenger Fare Investigation be processed for hearing and decision as fast as possible within the limits of due process and fair hearing.

Testimony and data introduced in the 6% case will be consolidated into the General Fare Case. The Board said much of the data would avoid needless duplication of time and effort. It added, however, that it may be necessary to provide for additional cross-examination and for submission of evidence by parties who did not participate in the 6% case.

Testimony Consolidated

The CAB said the hearing in the 6% case just concluded indicated there is a significant relationship between the Board's rate-making functions and the new equipment and financing plans of the domestic trunkline carriers. It said it believed, therefore, that the general case should include a full inquiry into the equipment and financing plans of the carriers for a full five-year period.

As a result, each trunkline carrier was ordered to produce for a future five-year period its equipment purchase plans, traffic forecasts, financing plans, equipment retirement plans and evidence as to the long-run effect of its future equipment plans and financing programs upon the general rate level and passenger fares. Airlines were asked to present

CAB Maps Near Collisions

These 331 near collisions were reported to the Civil Aeronautics Board in the first quarter of 1957, about the same rate as the last quarter of 1956. Map shows locations, with numerals in heavy dots indicating reports at places with too many to show by individual dot.

Vapor trails high in the sky will remind you that the 707 is flying its proving runs. Soon these fine planes, the first American jet transports, will come off production. American Airlines will be first to offer jet travel in the U. S. A. Early in 1959 American will use the 707's on transcontinental Mercury service.

AMERICAN AIRLINES
America's Leading Airline

North Atlantic Fares

Washington—Civil Aeronautics Board has reiterated its stand against approving a 15% passenger fare increase across the North Atlantic on the basis that no showing had been made as to the emergency need of the increase.

After the CAB first turned down the proposed increase (AW June 10, p. 45) European governments asked for reconsideration through the State Department.

Reconsideration also was asked by six individual carriers—Air France, British Overseas Airways Corp., Lufthansa, KLM Royal Dutch Airlines, Sabena and Swissair.

At the same time, CAB extended its approval of an International Air Transport Assn. agreement providing for a new low-fare, high density service across the Atlantic to March 31, 1958.

CAB approval of such service was originally scheduled to expire on Sept. 30. Implementation of the plan has not yet begun.

this information at an early stage after hearings begin.

"Closely related to the carriers' re-equipment program," the Board said, "is their ability to attract capital. In the light of this fact and the desirability of having full information on this aspect of the general fare problem, we will direct that the evidence as to rate of return be given first priority in the order of evidence to be received at the hearing.

The CAB said this new program carries out its pledge in the earlier announcement of its vote in the Suspended Fare Case "to maintain continuing surveillance" of airline fares. In announcing its vote earlier, the Board said the emergency relief requested by the seven carriers was not justified on the basis of the record before it.

Japan Studies Use Of Route Over Pole

Tokyo—Japan Air Lines hopes to open an international airline service across the North Pole by 1961 under a new 10-year aviation expansion plan now being studied by the Transportation Ministry.

The plan visualizes an air route between Tokyo and Copenhagen identical to the one inaugurated by the Scandinavian Airlines System in February. The route may be extended to London later.

In the light of the tremendous success scored by SAS's trans-polar service, JAL feels there is room for another airline along this route.

AIRLINE OBSERVER

► Aeroflot crews are now being checked out in four Ukraina turboprop transports prior to beginning regular service with the new Antonov An-10 transport on Aeroflot's domestic routes. Aeroflot has not yet taken delivery on any Ilyushin designed Moscow transports, and indications are that only the prototype is now flying.

► Conversion engineering on Fairchild's F-27 turboprop transport is progressing slower than expected, and the company now estimates the first delivery to West Coast Airlines in March, 1958, about 90 days later than the first delivery date scheduled. First aircraft is due off the line in December.

► American Airlines' public offering of surplus Convair 240s to the corporate aircraft market is primarily aimed at establishing a better price than the carrier might receive initially from feeder-line prospects in the current "soft" used transport market, industry observers feel. Executive plane prospects would be more likely to purchase aircraft at a price nearest American's figure, paving the way for a firmer bargaining position on future sales.

► Varig Airlines has completed a mutual traffic agreement with Japan Air Lines to facilitate travel between Tokyo, New York and Brazil. Under the agreement, JAL can confirm space on Varig without prior notification, and Varig has opened a ticket office in Tokyo. JAL has been authorized to fly between Tokyo and Brazil but has not yet implemented service on that route. As a result of the agreement, passengers from Tokyo will be routed to San Francisco via JAL, transferred to a U. S. carrier to New York, and then via Varig to Brazil.

► Air Transport Assn. says amendment of Civil Air Regulations to require installation of flight recorders on all aircraft flying above 25,000 ft. is a "needless expense." Amendment is scheduled to become effective on Sept. 9. Purpose of the recorders, the Civil Aeronautics Board says, is to analyze various incidents such as extreme vertical accelerations due to turbulence and for accident investigation purposes. ATA estimates the cost of the recorders at $2,500 to $3,000 each and says most, if not all, information obtained can be gathered from other sources. Since most turbine-powered aircraft of the future will fly above 25,000 feet installation of recorders would be mandatory under the CAB's rule change. Most of the present equipment operated by airlines would be excepted.

► West Berlin Research Committee reports that East Lufthansa expects a deficit for the current year of about $15 million at the East German and about $3 million at the West German conversion rate. The deficit is based upon the gap between operating costs and income. East Lufthansa figures cost per flight hour of the Il-14 at $110 an hour against an income of $55 an hour. East Lufthansa owns a total of 16 planes of the Il-14 type with 26 seats. Fifteen were supplied by Soviet Russia; one was built in Dresden, Saxony. Nine more aircraft of the same type are scheduled to be completed in Dresden by the end of this year and will be added to East Lufthansa's fleet.

► Efforts to streamline international airmail operations to keep pace with jet operations will be made at the 14th Congress of the Universal Postal Union in Ottawa. The meeting, which began last week, is expected to continue in September. Delegates from 96 member countries will attend.

► White House reports widespread interest regarding availability of aviation facilities planning reports. Reports are available at the Government Printing Office in Washington at nominal cost. They include: Aviation Facilities Planning, Summary-Final Report on National Requirements for Aviation Facilities 1956-1975, Air Traffic Volume, Aircraft Characteristics, Forecast of Aviation Activity and Modernizing the National System of Aviation Facilities.

► Northwest Airlines plans to begin DC-7C service on its domestic routes between Seattle, Chicago and New York by Sept. 1. Northwest has taken delivery on seven of 14 DC-7Cs on order.

Captain Thomas Bartley of Eastern Air Lines made his first *solo* flight 26 years ago. Since then, counting military service with the Troop Carrier Command in Europe during World War II, Capt. Bartley has flown over three and a half million miles. Today on the Eastern Air Lines' New York-Houston run from Idlewild Airport, he flies over 27,000 miles a month (a distance some 2,000 miles greater than that around the earth) *using Sinclair Aircraft Gasoline and Oil exclusively*... not to mention the Sinclair products he uses in his own car.

CAPT. THOMAS BARTLEY FLIES 27,000 MILES A MONTH WITH SINCLAIR GASOLINE AND OIL

When Captain Bartley takes off from New York on the Houston run, his Eastern Air Lines plane is doubly protected by Sinclair aviation products. Sinclair Aviation Gasoline and Aircraft Oil are teamed to give the mighty engines maximum power and superior lubrication. Sinclair is proud that Eastern places such confidence in Sinclair aviation products.

SINCLAIR

AIRCRAFT FUELS AND LUBRICANTS

Sinclair Refining Company, Aviation Sales, 600 Fifth Avenue, New York 20, New York

SHORTLINES

▶ **Iberia, Airlines of Spain,** will begin New York-Lisbon service on Sept. 4 using Lockheed Super-G Constellations. Eastbound flights will leave New York on Wednesdays for Lisbon, Madrid and Rome. Westbound, the new service will depart Rome on Thursdays for Madrid, Lisbon and, at the pilots' discretion, bypass Santa Maria, Azores, and fly nonstop to New York.

▶ **American** Airlines flew more than 700,000 passengers 473 million passenger-miles during July to set new July records for the airline. Passengers carried increased 9% while passenger-miles rose 8%. The airline also carried more than 7.3 million ton-miles of air cargo—this added to mail and express totaled 9,443,000 ton-miles, an 18.4% increase over July, 1956.

▶ **British Overseas Airways Corp.** will introduce the Bristol Britannia on two of its Middle East and Far East routes on Aug. 22 and 23. The turboprop transports will replace Lockheed Constellations on the London-Aden flight on Aug. 22 on a one-flight-a-week basis and on the London-Columbo route on Aug. 23, also on a one-flight-a-week basis. On Dec. 18, BOAC plans to begin daily service from New York to Nassau using a Vickers Viscount on tourist flights and a Douglas DC-7C on deluxe and first-class flights. BOAC reports that bookings for July on the Bermuda, Bahamas and Caribbean routes were 17% above last year and August bookings are up 52%. BOAC's transatlantic bookings are up 50% on tourist and 55% on deluxe and first class flights.

▶ **Hawaiian Airlines** reports 51,717 passengers carried during July, a 9.2% increase over July, 1956. Total passenger-miles rose 9.9% to 7,036,000. Cargo poundage carried by Hawaiian climbed 20% over July of last year.

▶ **Seaboard & Western Airlines** will increase its all-cargo service between the U. S. and Western Europe to seven flights a week in each direction on Sept. 1. Daily Monday through Saturday service will use Lockheed Super Constellations capable of an 18 ton pay-load. The Sunday flight will be made with a Douglas DC-4 which has a payload of nine tons. Seaboard & Western reports operating earnings increased 59% on increased revenues of 31% for the first six months of 1957. Total revenues rose to $11,991,000 against $9,148,000 last year. Out of this figure, earnings for the first six months were $661,779 compared with $415,997 in 1956.

COCKPIT VIEWPOINT

By Capt. R. C. Robson

Zero-Zero Landings—III

Instrument approaches in the experimental runway lighting project at Andrews Air Force Base during actual zero-zero conditions brought out many interesting facts concerning all-weather operations. We not only learned a great deal about the lights but also several things relating to crew coordination and the need for visual training aids.

As previously stated the weather on the night of April 26 was a pea soup condition—low fog. We have not yet had the opportunity to fly what Captain Peter Bressey of BEA calls the noodle soup mix. Admittedly this may be more interesting—especially when you run into a "noodle" at 50 ft.

On our flights the first indication of lighting was from the condenser discharge flashers. They appeared as pinpricks through the fog at about 250 ft. This provided directional information and an indication of any course displacement as well as serving as a "come on" to the pilot.

More Lights Appear

At about 200 ft. the glow of the fixed burning lamps became noticeable and between 100 and 150 ft. the individual barettes usually came into view. As mentioned in an earlier column we always had a good full view of the runway lights. Generally we began to make the transition from instrument to visual flight in the neighborhood of the 1,000 ft. bar on the approach lights and at the runway threshold we were definitely "off the gages." The 60 ft. narrow gage runway lights provided everything needed for touchdown—depth perception, attitude information, speed sense, etc. Any experienced pilot could have landed without hesitancy.

About five years ago I commented on the fact that a low approach was a two man job requiring close coordination between pilots. Never was this more clearly presented to me than during the Andrews work. My "crew" consisted of Capt. Walt Jensen, "co-pilot," and Capt. Ernie Cutrell and Capt. Dave Little as observers. Here is what we learned.

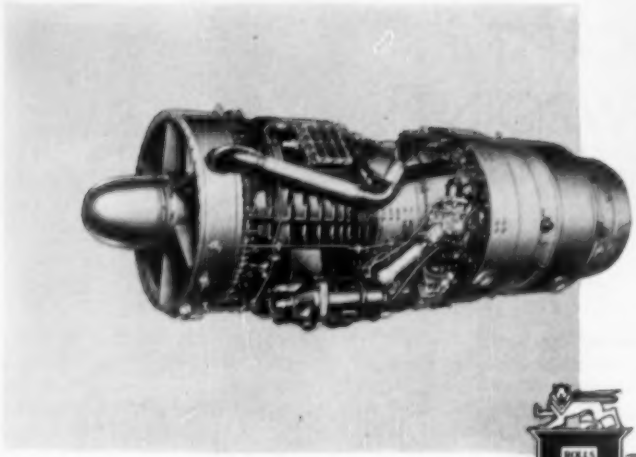
By the time the approach lights were clear enough to permit visual flying it was already too late for the pilot who was "on instruments" to look out, orient himself and make the landing with ease. The pilot who had been looking out the windshield on the other hand had, even before the individual barettes came into view, picked up considerable information concerning displacement, attitude, drift, speed, etc. But there was not enough time left for him to transmit this intelligence to the other pilot. There was general agreement that best operating practice may be to have one man act as "visual pilot," the other remain "on instruments." The visual pilot will take over the controls at some point to make the landing, or pull up if required.

British Conclusion

It is interesting to note that our British colleagues have come to similar conclusions regarding this division of duties and are beginning to use this method.

Considering the fact that the Captain is charged with making some sort of a weather observation prior to touchdown, as well as with the landing itself, it seems to follow that he should be the visual pilot and also over-all monitor. The co-pilot will stay "on instruments," or monitor the approach coupler if one is used, until the Captain takes over.

There is also the question of the need for a visual training device. Generally pilots do not have much opportunity to experiment in this type of weather and to work out an agreeable system. Since time is of the essence in the transition to visual flight zone a suitable trainer (such as the British use) might help prepare crews for the needed coordination. Fifty feet above the ground is no place to begin deciding who is going to do what.



AVON
turbo jet

DE HAVILLAND COMET
SUD-AVIATION CARAVELLE

ROLLS-ROYCE

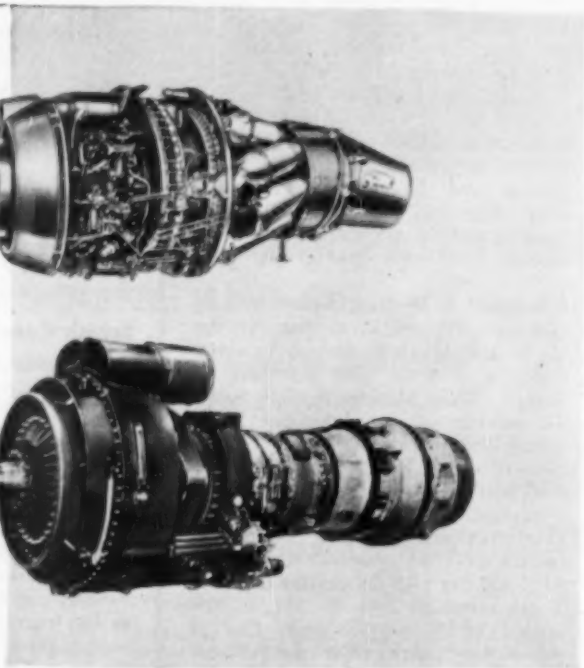
are producing three types of gas turbines for short and medium range airliners

DART
prop-jet

VICKERS VISCOUNT
FAIRCHILD F-27
AVIATION TRADERS ACCOUNTANT
ARMSTRONG WHITWORTH 650
HANDLEY PAGE HERALD

TYNE
prop-jet

VICKERS VANGUARD
ARMSTRONG WHITWORTH 651

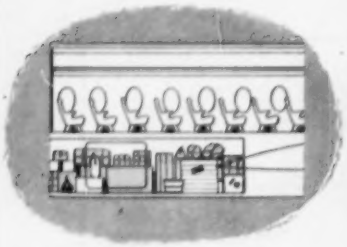


ROLLS-ROYCE LIMITED • ENGLAND • SCOTLAND • CANADA • AUSTRALIA

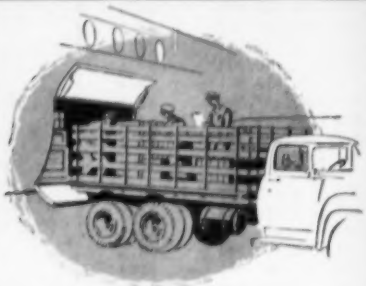
Airline Traffic — 2nd Quarter 1957

	Revenue Passengers	Revenue Passenger Miles	Load Factor	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	Per Cent Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	2,014,372	1,343,424	68 8	5,010,349	1,742,623	20,969,641	157,361,269	61 1
Braniff	515,629	222,803	60 6	783,415	267,836	1,496,074	23,935,796	49 3
Capital	1,037,669	400,087	61 1	1,241,747	411,858	1,234,378	41,213,241	48 9
Continental	207,870	87,873	55 5	254,990	82,954	418,833	9,192,377	46 3
Delta	685,669	339,544	62 6	1,024,747	505,369	2,321,375	36,537,875	54 0
Eastern	2,026,611	1,139,652	63 77	2,804,722	1,161,408	4,879,269	118,405,163	44 78
National	370,256	305,527	61 6	791,771	144,449	1,504,688	25,448,140	53 1
Northeast	175,412	48,759	53 5	64,039	44,759	155,717	4,930,525	43 6
Northwest	358,353	249,916	59 8	1,251,807	499,378	2,435,795	28,216,071	52 4
Trans World	1,185,412	931,987	67 7	3,087,916	1,296,982	7,341,077	101,147,334	59 8
United	1,609,928	1,194,390	66 6	7,044,192	1,550,131	14,803,813	138,134,073	58 3
Western	338,755	169,063	62 7	759,510	221,443	740,792	17,884,626	57 5
INTERNATIONAL								
American	84,172	23,953	57 6	178,339	1,084	883,595	3,470,587	63 5
Braniff	10,468	22,989	54 0	46,171	.....	221,462	2,779,516	50 8
Caribbean-Atlantic	55,468	3,872	52 74	4,552	.....	8,391	418,610	57 48
Delta	16,566	20,258	60 9	20,579	.....	179,754	2,451,486	53 8
Eastern	80,714	95,677	68 72	247,738	.....	241,093	11,481,160	42 4
National	19,046	13,087	42 5	22,388	47,825	99,063	1,500,561	67 7
Northwest	31,371	66,587	55 2	2,947,470	53,034	1,993,939	12,043,224	52 8
Pan American								
Alaska	21,184	22,930	58 4	128,382	.....	809,694	3,292,195	59 0
Atlantic	299,895	416,408	68 9	3,307,868	.....	5,826,202	52,829,723	61 1
Latin America	294,120	318,123	64 5	1,113,154	.....	10,577,928	42,077,227	58 4
Pacific	70,535	285,719	75 7	2,924,806	.....	4,418,359	37,096,341	68 1
Panagra	36,628	42,948	57 3	179,719	.....	1,056,087	5,857,014	60 8
Trans World	75,522	192,026	70 7	2,380,745	.....	2,133,893	24,544,883	71 5
United	25,317	63,185	66 8	310,310	.....	220,277	6,999,277	60 7
LOCAL SERVICE								
Allegheny	119,096	20,389	48 8	25,655	43,632	48,502	2,063,788	46 2
Bonanza	36,763	8,108	46 8	12,946	6,370	20,333	815,115	45 2
Central	31,081	6,143	35 3	12,044	11,073	20,607	626,730	31 5
Frontier	53,764	14,471	*	50,955	22,507	194,133	1,655,986	*
Lake Central*	.....	.....	.....	.....	.....	.....	.....	.....
Mohawk	110,437	20,720	49 1	74,227	121,670	266,965	1,641,803	49 5
North Central	166,094	26,866	48 7	61,930	72,818	.....	2,708,187	47 1
Ozark	103,027	16,843	41 7	33,790	41,256	49,886	1,734,374	43 6
Piedmont	110,047	22,842	56 7	40,488	24,074	45,307	2,302,868	56 1
Southern	56,521	10,004	42 1	27,897	26,849	.....	1,014,498	40 6
Southwest	83,908	77,998	52 4	29,017	13,588	21,587	1,780,254	50 5
Trans-Texas	63,536	14,479	38 2	41,444	19,668	70,582	1,512,982	38 6
West Coast	67,210	11,895	51 10	13,114	6,531	15,674	1,170,596	38 10
HAWAIIAN								
Hawaiian	105,138	15,784	59 7	12,546	.....	347,994	1,741,161	58 8
Trans-Pacific	52,280	7,209	56 9	4,006	.....	30,123	595,232	57 6
CARGO LINES								
Aerovias Sud Americana	.....	.....	.....	.....	.....	2,204,247	2,204,167	79 8
Flying Tiger	28,670	145,192	99 0	112,654	68,187	30,368,461	34,253,072	84 1
Riddle	.....	.....	.....	133,164	46,475	2,751,393	6,931,032	64 7
Seaboard & Western	8,381	49,355	100 0	.....	.....	7,929,477	10,416,737	79 4
Slick	23,201	88,581	93 18	265,109	117,284	13,414,998	22,718,497	73 55
HELICOPTER								
Chicago Helicopter	11,530	171	32 2	75,927	.....	.....	23,942 1	33 6
Los Angeles Airways	8,618	354	54 16	12,609	4,720	.....	45,012	61 02
New York Airways	19,011	345	38 2	5,285†	2,641	1,702	42,590	42 4
ALASKA								
Alaska Airlines	1,280	2,058	19 4	54,730	.....	528,006	792,659	38 4
Alaska Coastal	14,602	1,263	60 9	11,677	.....	12,351	152,891	61 7
Cordova*	.....	.....	.....	.....	.....	.....	.....	.....
Ellis	16,765	958	57 5	5,440	.....	9,170	112,023	67 5
Pacific Northern	29,076	29,059	54 9	261,448	.....	868,916	4,275,528	61 8

*Not available.
†Mail transferred in bulk.
Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

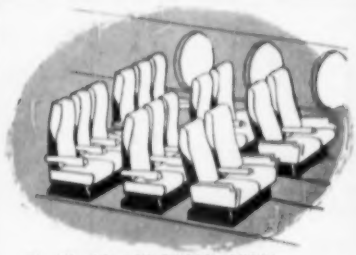


2-IN-1 AIRCRAFT!
The Vanguard's double-deck fuselage makes it the most flexible airliner built. Though primarily a passenger plane, during low traffic periods it can continue to bring in revenue operating solely as a freighter!

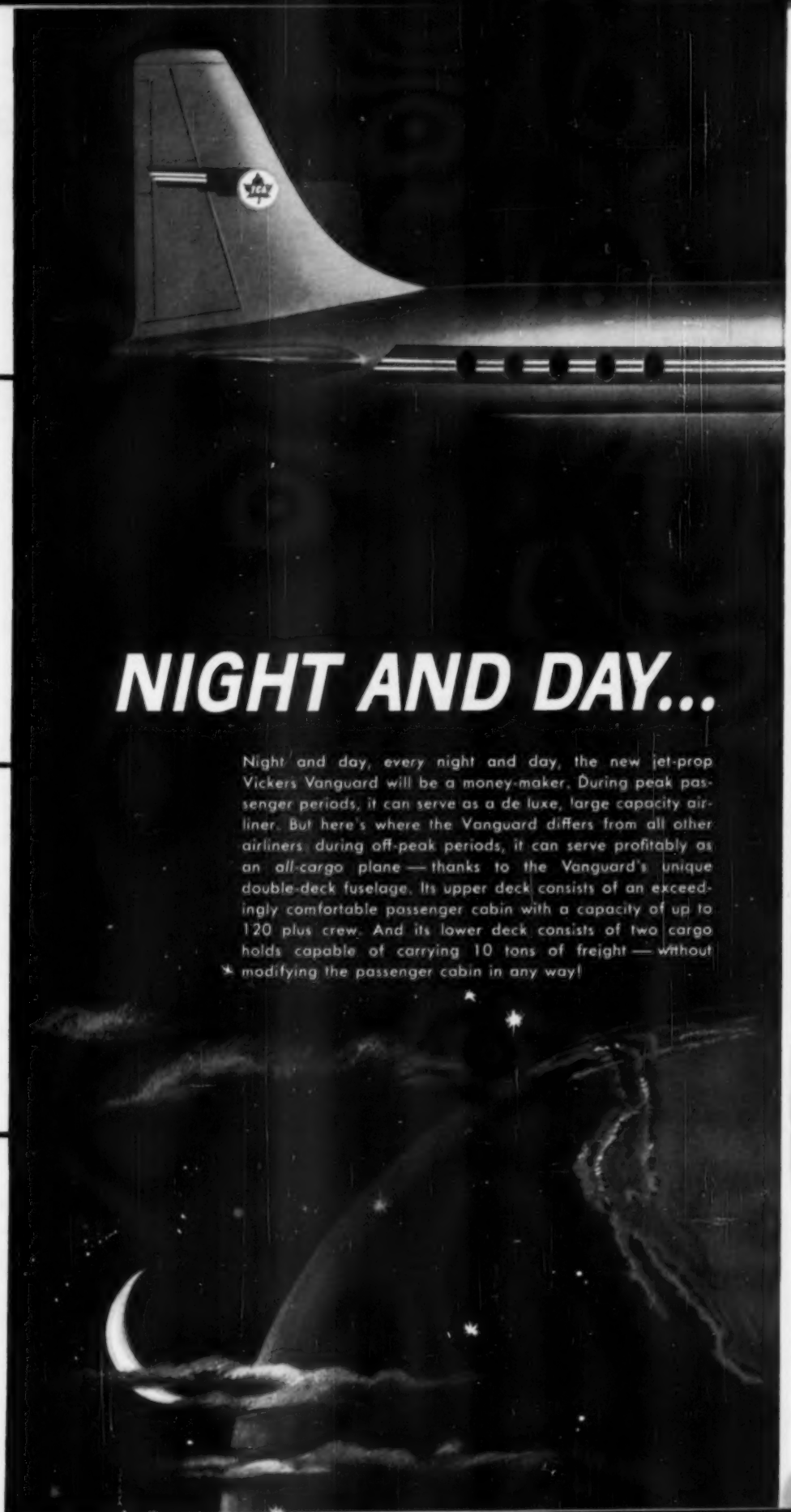


10 TONS OF FREIGHT!
The Vanguard's two lower deck cargo holds have a capacity of nearly 1400 cu. ft. — enough to carry the plane's full payload in high density freight. With two 5' 6" wide doors, cargo can be simultaneously loaded and unloaded quickly, easily.

UTMOST PASSENGER COMFORT!
The new Vanguard has all the comfort features that have made the Viscount so popular with passengers: the quiet and smoothness of jet-prop flight . . . king-size panoramic windows . . . wide, fully-reclining seats.



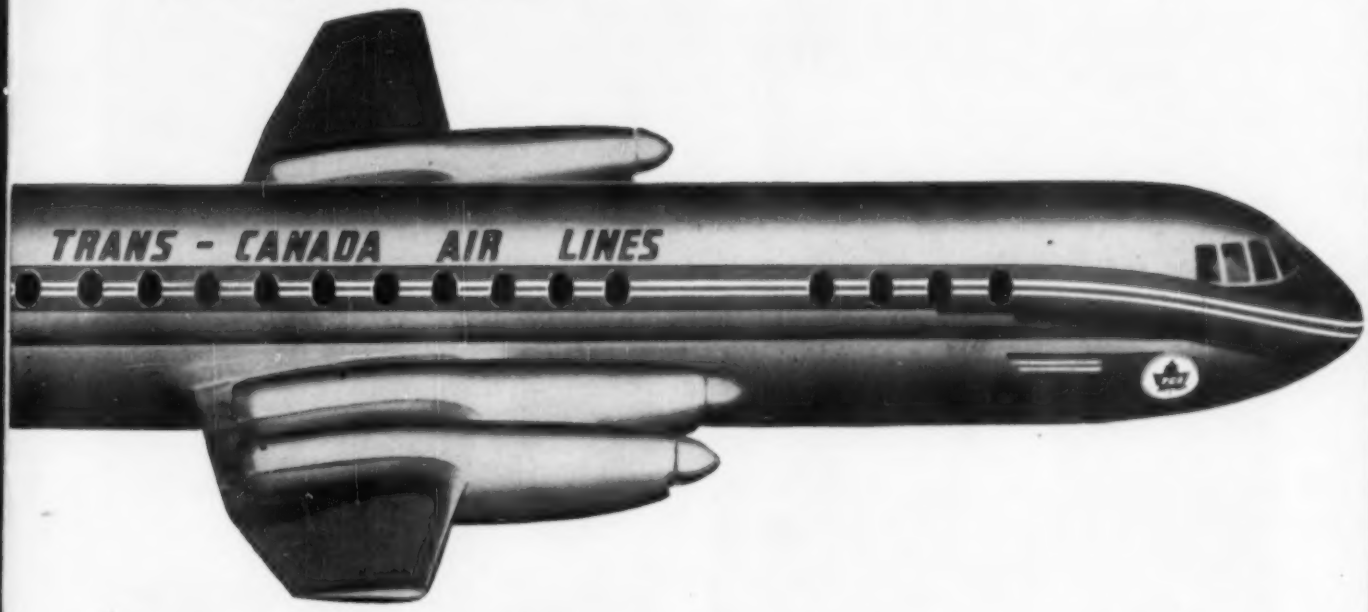
76, 86, 93, 120 PASSENGERS!
The luxurious upper deck passenger cabin has unusual layout flexibility . . . can be adapted to all first-class, mixed-class or all tourist accommodations.



NIGHT AND DAY...

Night and day, *every* night and day, the new jet-prop Vickers Vanguard will be a money-maker. During peak passenger periods, it can serve as a de luxe, large capacity airliner. But here's where the Vanguard differs from all other airliners: during off-peak periods, it can serve profitably as an *all-cargo* plane — thanks to the Vanguard's unique double-deck fuselage. Its upper deck consists of an exceedingly comfortable passenger cabin with a capacity of up to 120 plus crew. And its lower deck consists of two cargo holds capable of carrying 10 tons of freight — without modifying the passenger cabin in any way!

The new double-deck jet-prop VANGUARD



A FULL-TIME MONEY-MAKER

EXCEPTIONALLY QUICK TURN-AROUND!
The new Vanguard was designed with quicker turn-around in mind. Result: remarkably fast freight and passenger handling and outstanding ground maneuverability. Each of the Vanguard's two cargo holds has an extra-wide door at truck loading level. There is ample floor space and working height inside. To facilitate passenger flow, there are cabin doors fore and aft — each with built-in folding stairs.

Because of its minimal turning circle of 74′ and the clear view from the pilot's cabin of both outer engines and wing tips, the Vanguard can be safely and quickly maneuvered even on crowded ramps. With its low pressure tires, the Vanguard can use existing runways of most airports.

Powered by four Rolls-Royce Tyne jet-prop engines, the Vanguard will be capable of speeds up to 425 mph over a 2500-mile range with a full payload. The Vanguard will have a low noise level and will create no special airport noise problems. Into each Vanguard will be built over 2 million flying hours of Vickers jet-prop experience. And there's no substitute for experience!

jet-prop VICKERS VANGUARD

POWERED BY FOUR ROLLS ROYCE-TYNE ENGINES

U.S. REPRESENTATIVE: CHRISTOPHER CLARKSON
10 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

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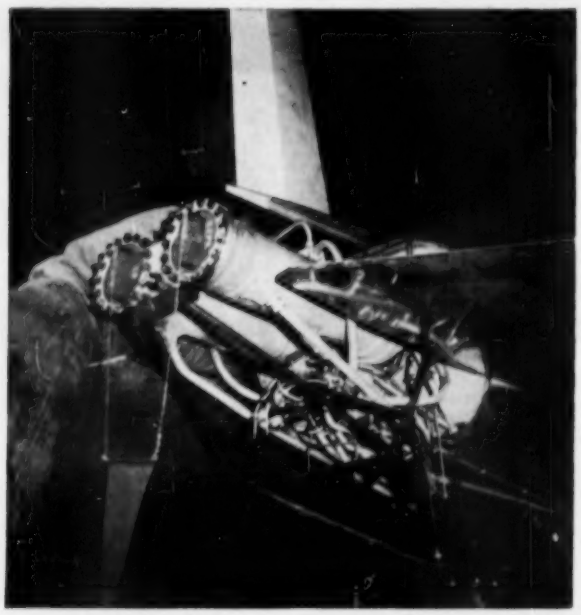
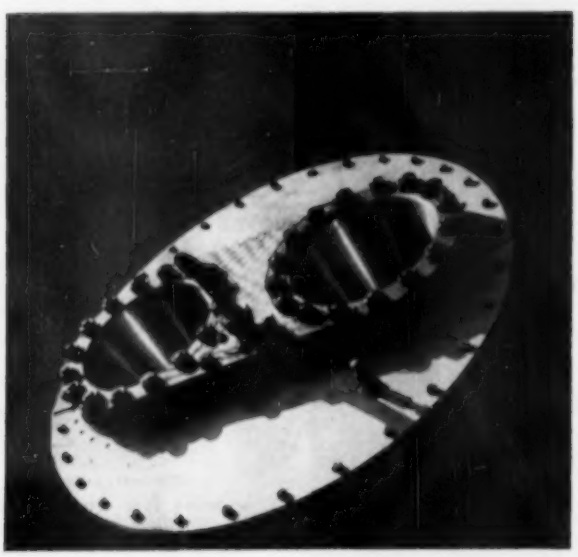
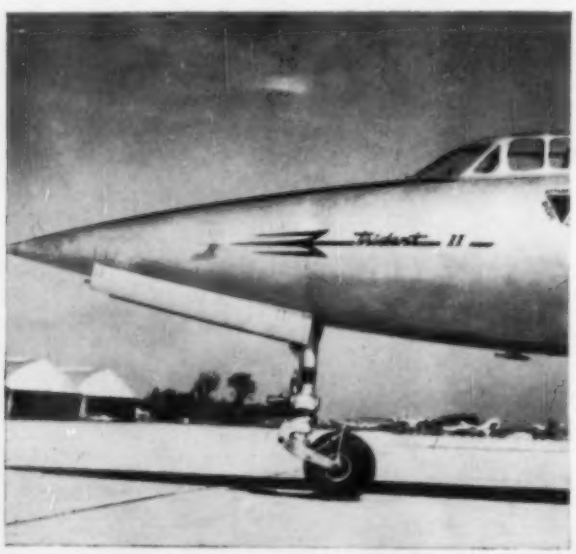
MEMBER COMPANY OF THE VICKERS GROUP

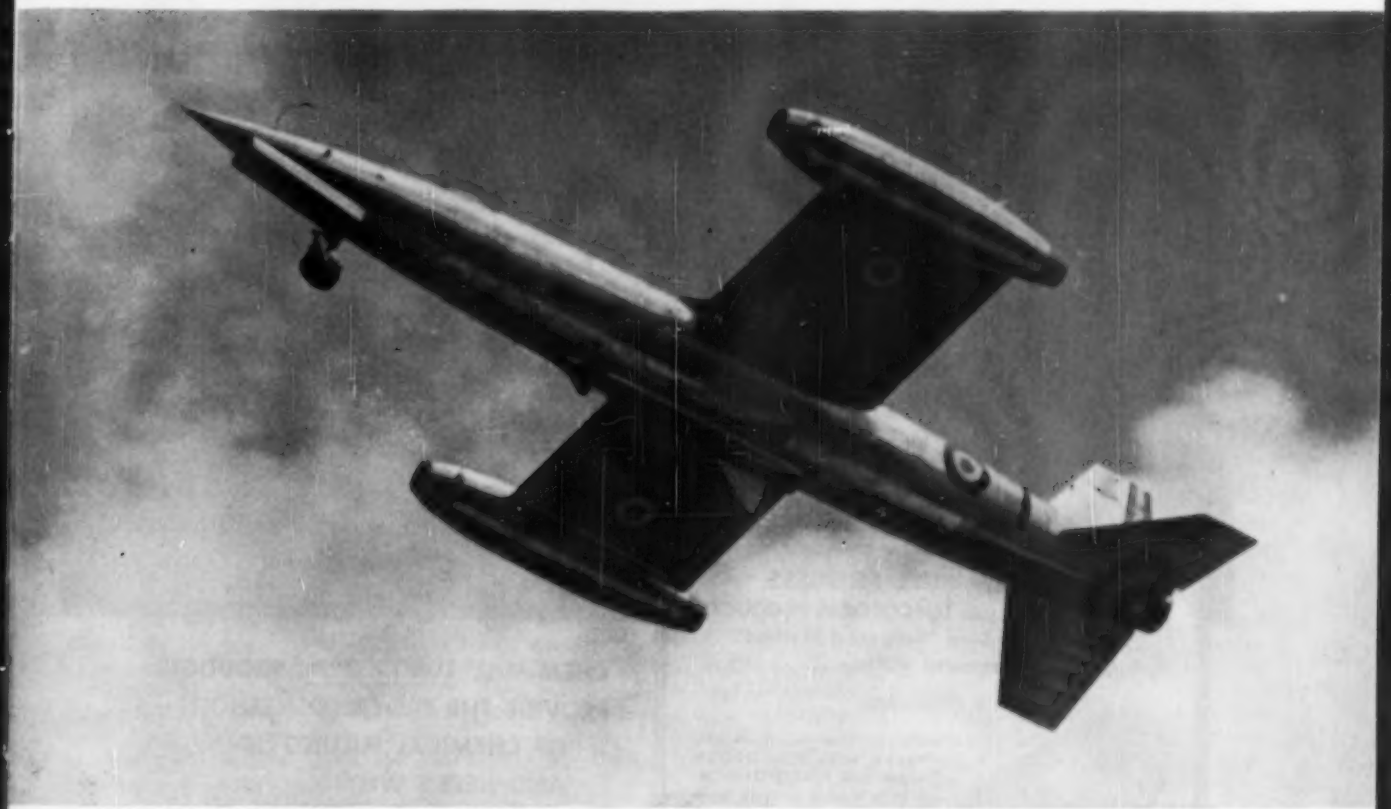
TIEDOWN TEST of Trident II checks out one of the two cylinders of SEPR rocket. Check is a standard preflight procedure.



SEPR rocket engine installation (above, left) is a complete package and attached under curved fuselage bottom bulkhead. Twin nozzles are in tail (below). Nosewheel well (above) was lengthened to take lengthened landing gear of Trident II. Longer nose (below) is one of design changes in pre-production series. Small radar is in nose compartment ahead of wheel well. Cockpit hood is one-piece steel forging.







TRIDENT PLUS MISSILE is envisoned second-step development of this mixed powerplant interceptor. Plane has exceeded Mach 1.8 military requirement. Concept called for ground control to target vicinity, target acquisition and firing by pilot.

Trident Blends Simplicity, Performance

By David A. Anderton

Paris—Sud Aviation's Trident mixed-powerplant interceptor is probably the simplest high-performance aircraft ever built.

With component parts numbering only in the hundreds—the wing, for example, contains 33 different pieces—the Trident has excited great interest as a possible "common production" aircraft to be built by an inter-European enclave.

Mach 2 Candidate

Its performance makes it a serious candidate for the job of European local air defense. It has a top speed above Mach 2 and a ceiling limited by human factors only. Its rate of climb gets it to 50,000 ft. in about two minutes and thirty seconds after brakes are released at the start of the takeoff run.

Simplicity of the design and its rugged construction make the Trident capable of field operations with minimum equipment and facilities. Its development program, which envisioned a transition from a piloted interceptor to a ground-to-air pilotless missile, has been passing through its planned phases on schedule.

In spite of all this, the future of the Trident is uncertain. In this respect it shares status with its sisters in France, technically brilliant in concept and design, but with little hope for a future as high-volume production airplanes. Lack of funding in the end will always defeat technical ability.

Today a batch of ten pre-production Trident II interceptors is underway at Sud Aviation. There are no follow-on orders. These ten, designed to specific military requirements, are to be used for service testing by the French Armee de l'Air in a variety of simulated missions and operations in the field.

If all goes well, a production order for the Trident II or a later Trident III could be the outcome.

Recent order for tooling of the Dassault Mirage (AW July 22, p. 32) plus ten pre-production aircraft may mean that the piloted version of the Trident will never see service and that the company will skip over any intervening models directly to the ground-to-air missile.

Regardless of the technical differences between the two airplanes, both have been designed to the same basic concept of the mixed-powerplant interceptor.

Larger Turbojet

The Dassault airplane, with a proportionately larger turbojet and more fuel capacity, can double as both interceptor and fighter-bomber. This cannot be done by the Trident in its present form.

Versatility may have been major reason for giving the nod to the Mirage instead of the Trident.

Regardless of the outcome of the test program and the fate of the plane, the Trident is unusual and worth dissecting from an engineering viewpoint. At first glance it resembles a winged missile with a cockpit added as an afterthought. But a close look under the smooth skin shows an integrated design

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of a simple airplane designed for a simple mission.

Original concept of the Trident mission was that of the "one-shot" interceptor, a light aircraft with a terrific rate of climb and high supersonic speed coupled with the ability to maneuver at extreme altitude. The mission profile was a simple one—incoming bombers were the target.

The Trident was to take off and climb toward the target, vectored by ground control. It was to get to an altitude preferably above the bombers and on spotting them would pick out one and go after it. With a single air-to-air missile, it could only strike once, and then return to base.

Engine Program

The chosen formula for this task was that of the mixed powerplant, a combination of turbojet and rocket power. Takeoff would be on the combined powerplant. Once in the air, the rockets would be shut down and the climb begun on turbojet power alone. At an altitude near 30,000 ft., the first chamber of the rocket would be cut in, followed by the second and third in a programmed firing sequence carefully optimized for maximum performance at altitude. After pursuit of the target and firing the offensive missile, the rockets could be shut down and the Trident would return to base either as a glider or at low cruise thrust on its turbojets. Landing would be with turbojet power, or could be with no power at all.

Having established some of the basic considerations as a philosophy, Designer Lucien Servanty began work in 1948 on the Trident series. His aim was to develop the interceptor through a well-defined, step-by-step program whose first phase was to be the Trident I, a development prototype with a speed of Mach 1.5 and a target date of 1954. From that plane, the design series would progress through piloted military versions to a pilotless missile, should that be the optimum ultimate stage.

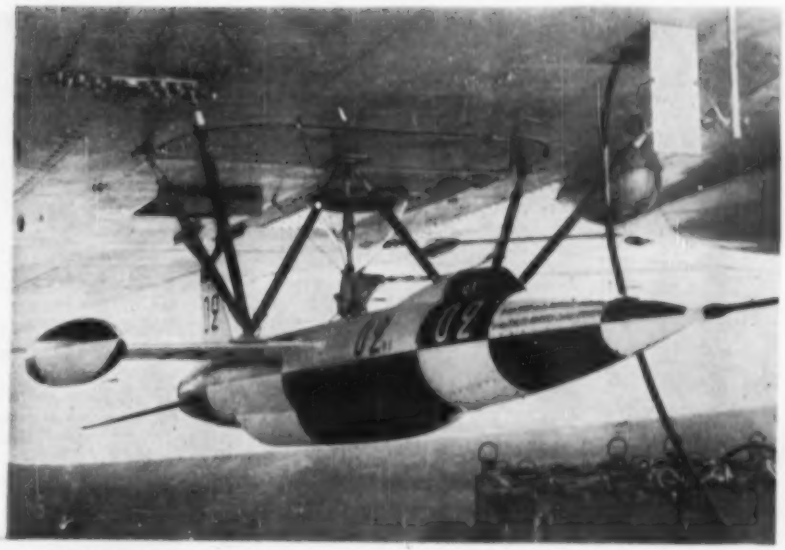
Trident Layout

Servanty's original layout is almost duplicated in the Trident II today. The plane is simple. Its geometry can be drawn almost entirely with compass and straightedge.

Fuselage of the Trident is circular-arc or ogival profile with a fineness ratio at about ten.

All sections through the fuselage are circular. Overall length of the Trident II is 42 ft. 6 in.

The pointed nose contains a small radar used only during the final phase of the attack. Behind it is the nose landing gear well. The cockpit is covered with a one-piece steel forged hood of exceptionally rugged construction to take the large pressure differentials at extreme altitudes.



DROP TEST MODEL of Trident was used to check nose section ejection and separation in tests of original escape scheme. Capsule idea has been abandoned, replaced with simple ejection seat.

The whole forward fuselage section from just aft of the cockpit was designed originally to separate as an escape capsule. Tests eliminated this idea and today the Trident has a conventional ejector seat.

Aft of the cockpit, the fuselage is full of fuel and accessories, linkages for controls, the hydraulic system etc. The SEPR 631 rocket engine is in the tail cone, and its lines, valves and other components are in the rear fuselage belly under a shallow curved longitudinal bulkhead which serves to complete the fuselage ring structure. The rest of the belly contour is simply a non-loadbearing fairing.

Straight Wing

Trident II's wing is of constant-chord and very low aspect ratio, approximately 2.5, but this low figure is increased aerodynamically because the turbojet engines mounted in nacelles at the wingtips act as an end plates. Front spar is at about 15% of the chord and the rear spar is about 75%. Wing thickness is a constant 6%.

Takeoff wing load is about 73 psf. The figure decreases to 41 psf. for landing.

Entire wing section between the spars is a foil honeycomb structure. Hydraulic and fuel lines and electric conduits for outboard services run along the front face of the front spar. Eight interchangeable leading-edge sections fasten on the front spar, these of solid honeycomb.

There are no ailerons, but the trailing edge of the wing is a full-span flap.

Wing is structurally one piece straight through the fuselage. Its total span including the turbojets is about 22 ft. 6 in. Of this, only about 17 ft is actually wing.

All stability and control about the three axes is furnished by a trio of slab tail surfaces, one vertical and the other two set about 20 deg. below the horizontal. These surfaces operate together or differentially to provide maneuverability. They are also low-aspect ratio surfaces, and are trapezoidal in planform with swept leading edges. The surfaces are 6% thick at the root and 4% at the tip.

Irreversible Jacottet-Leduc servo-controls are used.

Speed brakes are located on the upper fuselage between the vertical tail and the sub-horizontal surfaces.

Landing gear is built by the French firm Messier.

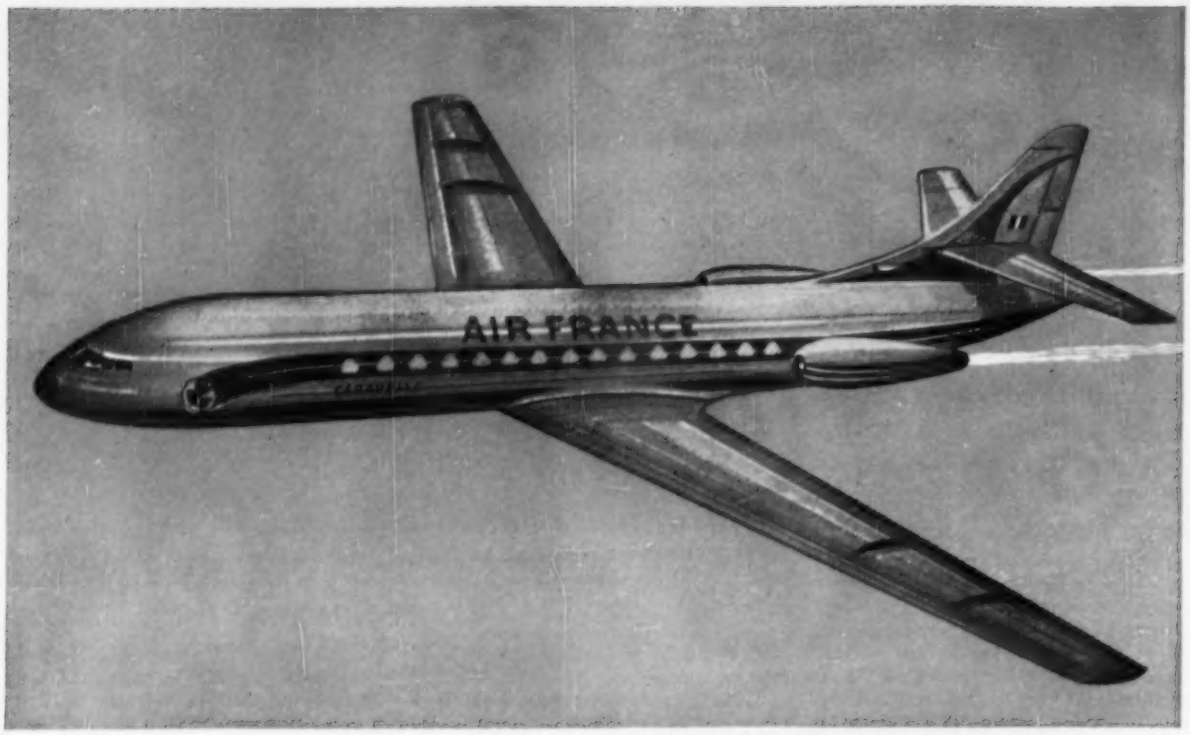
Powerplant Growth

In the first prototype Trident, designated SO 9000-01, the wingtip turbojets were Turbomeca Marbores rated at 880 lb. thrust each. The rocket engine was the three-barrelled SEPR 481 which developed 9,900 lb. thrust, or about 5.6 times the turbojet thrust.

Total thrust available was about 11,600 lb. which approximated the takeoff gross weight of the Trident I.

Re-engined with Dassault-built Armstrong-Siddeley Vipers of 1,670 lb. thrust each, the prototype had improved climb performance and greatly improved safety for approach and landing.

It also had single-engine performance, something that was almost lacking in the original configuration. Ratio of rocket to turbojet thrust de-



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Four Trident Versions

Basic Trident design now includes these variations:

Trident I (SO 9000), the prototype development aircraft. This plane exceeded Mach 1.6 in level flight. Its primary purpose was to develop aerodynamic data through flight tests for the Trident design and to get such other flight test data as possible.

Trident II (SO-9050), the pre-production aircraft. These are designed to a military requirement and will be used to fly simulated missions and to do other development work. This version is not now matched to a missile, but several missiles have been considered and some flight-tested on the Trident II. Design changes from the Trident I include a modified canopy, lengthened landing gear, lengthened fuselage, and replacement of the SEPR three-barreled rocket by a two-barreled unit. Speeds in excess of Mach 2 are expected from this plane.

Trident III, an advanced Trident II. Basic difference here is that the turbojets are to be more powerful and will have afterburners. This will require more internal fuel, so that the fuselage might be expected to lengthen again. Landing gear is to be strengthened for operations from unprepared fields.

Trident IV, reported as a pilotless version. This designation is a provisional one, and probably refers to the development of the Trident in which the pilot is replaced by a guidance system.

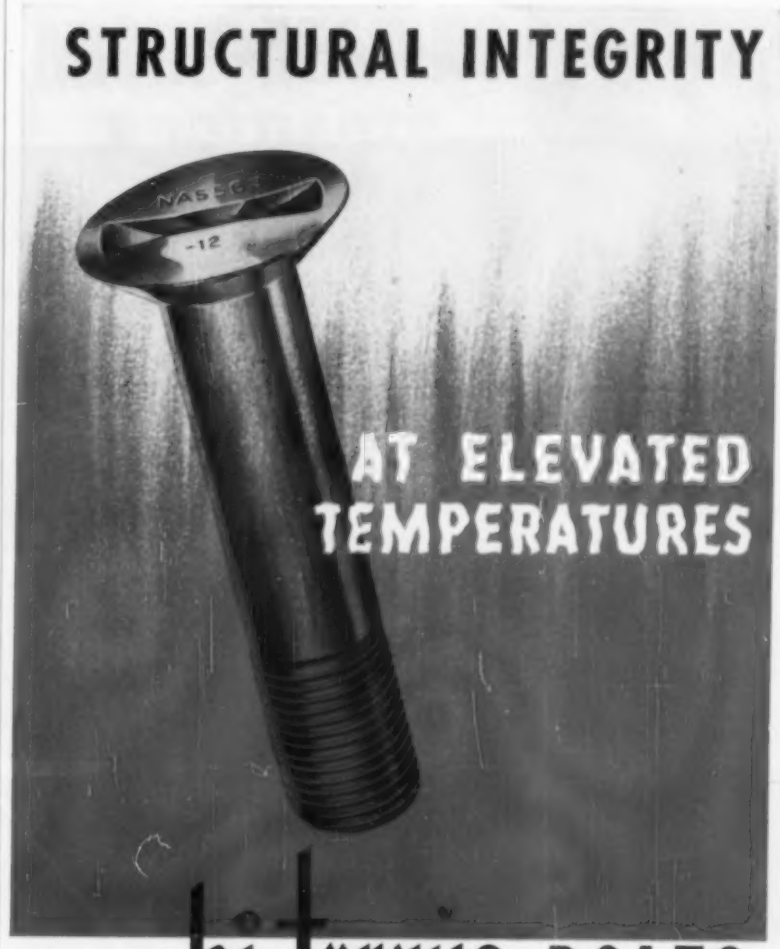
creased to just below three. Thrust-weight ratio improved somewhat.

With the change to the Trident II prototypes, the turbojets became advanced Dassault-built Vipers developing 1,760 lb. thrust each. Also on the Trident II, the rocket powerplant was changed to the SEPR 631, basically the same engine but with two thrust chambers instead of three. This dropped the rocket thrust to 6,600 lb. Ratio of rocket to turbojet thrust decreased to less than 1.9. Total thrust was 10,120 lb. which is under the current takeoff weight of 11,355 lb.

Future Tridents will have still more turbojet power, using the Turbomeca Gabizo rated at 2,420 lb. each in the first Trident III. Ratio of rocket to turbojet thrust there will be less than 1.4. Later versions of the Trident III are expected to have Gabizos with afterburning, rated at about 3,330 lb. thrust each. This will drop the rocket-turbojet thrust ratio to unity. The thrust-weight ratio should increase to about 1.1.

The SEPR Rocket 631 now powering the Trident II is furnished to Sud Aviation as a complete package, taking up the tail cone section of the fuselage

STRUCTURAL INTEGRITY



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* Superalloys such as A-286, Inconel X, S-816, M-352, J-1570, Inconel 700 and Haynes 25 are now available in the Hi-Torque configuration. Precipitation hardening stainless steels—AM 350, 17-4PH and AM 355—are also available.

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plus a gore-shaped cross-section of the fuselage along the belly. Lines, valves and other fittings run along the fuselage belly in this bay completely isolated from the fuselage structure. This design layout was adopted as a safety consideration to assuage the pilots who were not pleased by the thought of loose acid leaking on the primary structure.

The 631 rocket is basically a modification of the engine in the prototype Tridents. That early engine had three combustion chambers and developed a thrust of 3,300 lb. per chamber. The unit could be step-fired in one, two or three stages to develop programmed power between 3,300 and 9,900 lb.

The 481 engine was cleared for flight in 1954 after an intensive ground-run program. Subsequent testing included 120 hot runs during flight and more than 1,200 static ground runs. The combustion chambers were ignited about 2,700 times during these tests.

Rocket Change

The 481 powerplant was terminated when the Trident II began its portion of the development flying with the 631 engine. But the prototype Trident I had by then exceeded a speed of Mach 1.6 at about 53,000 ft. altitude.

Propellants for the SEPR engines are nitric acid as the oxidizer in 98.5% concentration and furaline as fuel. In addition to tankage for these propellants, space must be made for water and methanol which are injected into the combustion gases driving the turbopump assembly.

When Servanty started with the Trident program in 1948, his project team had completed the designs of the SO 6020 "Espadon" (Swordfish) and were looking for a new airplane. The Trident concept began to take shape on the drawing boards and in calculations on paper. The French Air Ministry accepted Servanty's concept of an experimental aircraft first to prove certain principles, and authorized the work on the Trident I. But there were no supersonic wind tunnels available in France to get the kind of aerodynamic test data that Servanty thought necessary.

Wind tunnel tests were made in the United States on the first Trident layout using the Navy Ordnance Laboratory tunnels at White Oak, Md., near Washington.

These were steady-state tests, and in addition to giving the usual parameters of lift, drag and moments, were also made with deflected control surfaces to get complete hinge-moment curves for stability and control calculations about all three axes.

Actually no transonic data became available before the flight test program, and the Trident flew through Mach I

MICRO-BEARING ABSTRACTS

by A. N. DANIELS, *President*
New Hampshire Ball Bearings, Inc.

BEARING FITS AND FITTING PRACTICES

As shown in *Fig. 1*, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the housing and the outside diameter of the bearing; the bore of the bearing and the shaft diameter.

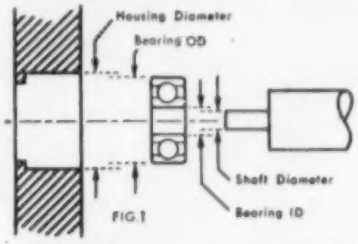

FIG.1

The achievement of the desired fit by dimensioning is illustrated in *Fig. 2*. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearing outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a .00015 tolerance with a similar tolerance for the shaft. A resulting fit of line to line to .0003 loose is shown.

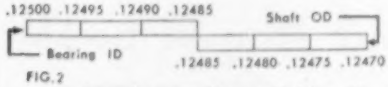

FIG.2

An interference fit not tighter than line to line is suggested for the following reasons:

1. *Difficulty in assembly.*
2. *Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.*
3. *Reduction in radial play.*
4. *Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.*

TOLERANCE DISTRIBUTION

The maximum .0003 loose condition shown in *Fig. 2* may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the maximum tight fit of line to line. The looseness may be reduced by redimensioning the shaft to .12490/.12475 as shown in the block diagram, *Fig. 3*.

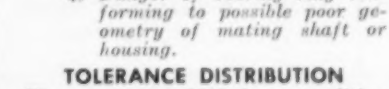

FIG.3

If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve cannot be assumed. During the grinding operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grinding and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizeable. But the approximate distribution of shaft and housing sizes must be verified if this method is to be used.

MATERIALS and SURFACE FINISHES

The ease of assembly is also affected by materials and finishes. The following factors must be considered:

1. *The galling characteristics, hardness and ductility of the materials involved.*
2. *Finish lay patterns produced by various tools and techniques used.*
3. *R M S surface finish values achieved.*
4. *Geometry of shafts and housings as regards out-of-roundness, taper, etc.*

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without the benefit of corroborating calculations. Much later wind tunnel work has been done in French facilities, however.

Test Vehicles

Some of the basic components of the Trident were tested in prototype form on the Espadon prototypes. The complete power control system for Trident, using its irreversible Jacottet-Leduc servos, was flown on the SO 6021. The original prototype SO 6020 was modified to carry Turbomeca Marbores at its wing tips to check out the engine functioning and airplane response under such a layout.

The SEPR rocket was flight tested on two of the prototype Espadons, the SO 6025 and 6026. The former had a single-chamber SEPR 25 rocket in a package under its belly. The latter used an SEPR 251 engine mounted in the fuselage tail.

One-third dynamically similar models of the Trident were made and air-dropped to check separation, trajectory and recovery of capsule nose section.

The first prototype Trident I flew on March 2, 1953, with Jacques Guignard at the controls. Only the Marbore powerplants were used during the early flight test program. On August 30 that year, Guignard had just gotten the Trident off the ground and was beginning to climb when the turbojets cut out.

Fan for Jetliner

This lightweight, high efficiency fan, developed by General Dynamics Corp.'s Electric Boat Division for ventilating the nuclear-powered submarine Skate, will also see service in the air conditioning system of the 880 jetliner being built by General Dynamics' Convair Division. The vaneaxial fan incorporates slotted blades for maximum efficiency. Unit, including a 10 hp. electric motor, weighs about 22 lb. and has a 7½ in. diameter. The new fan is now being supplied to the Hamilton Standard Division of United Aircraft for the 880's air conditioning system. Picture shows fan being checked for sound-free operation with a vibration probe while resting on an isolated half-ton steel slab.

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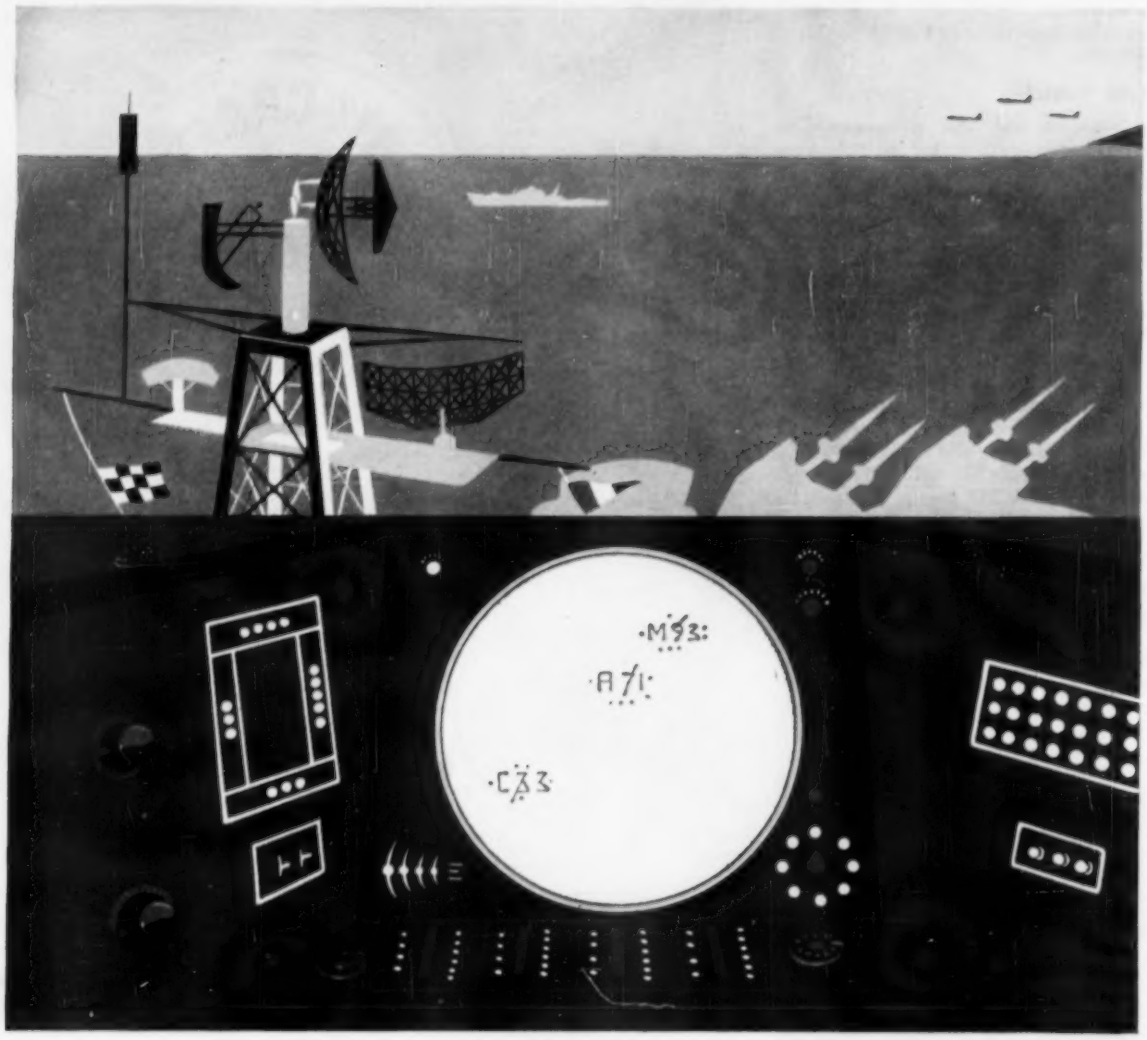

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USAF Aircraft in Group Portrait

Major combat and support aircraft of the Air Force are photographed together at the Air Proving Ground Command, Eglin AFB, Fla. Clockwise around the outer circle, starting with the Convair F-102 interceptor (center, bottom) are North American F-100, Martin B-57 bomber, Douglas B-66 bomber, Boeing B-47 bomber, Boeing KC-135 tanker, Boeing B-52 bomber, Douglas C-124 transport; Boeing KB-50 tanker, Lockheed C-130 transport, Grumman SA-16 amphibian, Northrop F-89D interceptor, McDonnell RF-101 reconnaissance aircraft. In the inner circle, starting at the lower left, are North American F-86D interceptor, Lockheed F-94C interceptor, Lockheed RC-121 reconnaissance (military Constellation with radome), Convair B-36 bomber, Boeing KC-97 tanker, Republic F-84F fighter, North American F-86 fighter. In the center are a Sikorsky H-19 helicopter and a Cessna T-37 jet trainer.

Guignard rode it out to a crash and was seriously injured.

Charles Goujon took over as project pilot and made the first rocket powered flight on September 4, 1954. The prototype topped Mach 1 in a climb in April, 1955.

Meantime, the early success of the flight test program and its single near-disaster produced two effects. First, the French Air Ministry became convinced of the value of the concept and ordered the Trident II to a military requirement, specifying a top speed above Mach 1.8.

Second, the prototype was re-engined with more powerful turbojets, the MD 30 (Dassault-built) Vipers.

The Viper-powered craft made its first flight on May 17, 1955. The Trident II was constructed in 14 months and made its first flight on its turbojets only on July 19, 1955, with Goujon flying. Its first rocket flight was later that year, on December 21.

Guignard, recovered from his early accident, got back into the Trident program again, only to have another powerplant cut out on Jan. 5, 1956, while he was making a landing. The Trident landed short of the runway, and neither Guignard nor the plane was badly hurt. Nineteen days later the Trident II went supersonic for the first time.

Since then, it has topped Mach 1.9 with the Viper powerplants, leaving no doubt that the top speed of the Trident III coming along will be over Mach 2.

This spring Goujon was killed during a test flight. The official investigation is still going on, waiting, among other things, for the harvesting of the field into which the bulk of the airplane fell. After harvesting, mine-detectors and search should produce a majority of the rest of the wreckage.

Sud Aviation says that it was not the rocket powerplant, the turbojet engines or the airframe that caused the tragedy.

Trident III

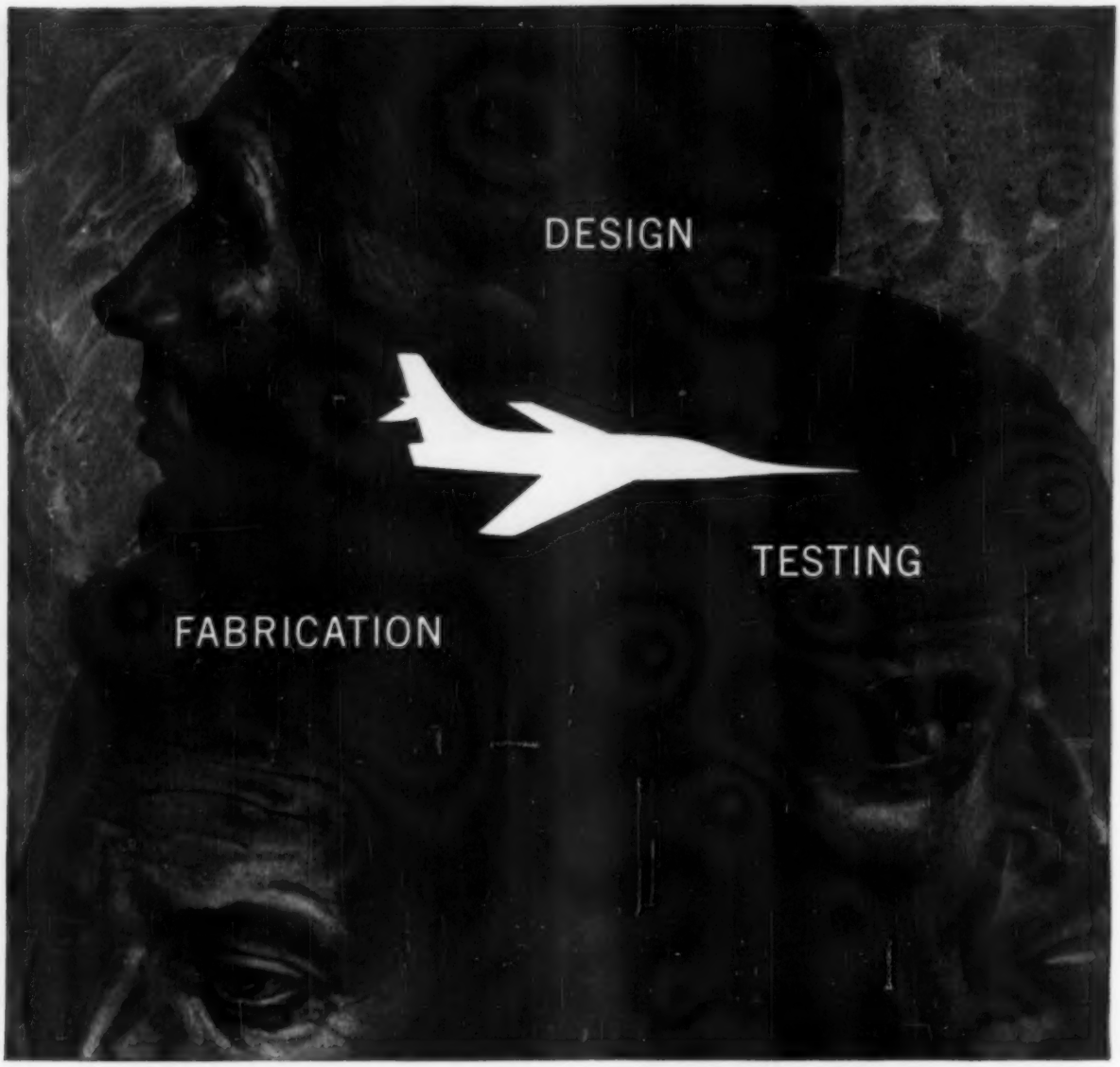
Current status of the Trident program is that Sud Aviation is completing the third and fourth planes of the ten pre-production models on order. Following these could come the Trident III, externally similar to the earlier models but with afterburning Gabizo engines at the wing tips, more fuel and reported grass and rough-field capability.

The third Trident II is now on the floor having Gabizo engines without afterburner units installed at its wing tips. Thus it will become aerodynamically a Trident III and will be used to fly parallel tests with the Trident II to get some comparative data.

Flight time in the program is well over 250 hr., a large figure for a rocket-powered plane whose mission profile is measured in minutes. Most of this time was racked up on the Trident I before its flight test and development program was terminated in favor of the Trident II.

Whether or not the Trident III gets a production order, or whether or not the missile development goes ahead depends now on political and fiscal factors rather than technical. At this stage, French engineers could have developed the world's finest complete weapon system and yet could never build it because of lack of funds.

So it is with the Trident. Versatility of concept was not a design requirement, and is difficult to build into an aircraft of this type. Servanty and the 60 engineers and technicians on his project team have accomplished a formidable design program, but its future is cloudy.



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Convair Converts Test F-102As To Latest Tactical Configuration

Ft. Worth—Convair is in the midst of a modernization program here in which early models of the F-102A interceptor are converted from test versions to the latest tactical configuration.

In this Test-to-Tactical program, Convair takes F-102As which were built for test purposes and converts them to the current tactical version. This conversion includes all production changes made since the test F-102As left the factory.

First delivery of a revamped F-102A was made last month to the 438th fighter Interceptor Squadron at Kinross AFB, Michigan. Work on the initial block of 18 aircraft is well along toward completion.

Program Future

Convair and the Air Force are negotiating contracts on further groups of F-102s to be phased into the program. Test-to-Tactical could conceivably evolve into a regular IRAN program for the Convair aircraft.

These are the major changes made in the F-102As going through the Test-to-Tactical program:

- **Larger tail** is installed.
- **Radar system** is modified and improved.
- **Missile bay doors** are modified to handle larger rockets.
- **Air inlet ramp** is extended to eliminate cockpit noise problem.
- **Automatic flight control** system is replaced with a newer version.

Although these features in the modernization program all coincide with changes made in the F-102A production line since the ships left the factory, some of the features were actually pioneered in the Test-to-Tactical program before they appeared on the production line.

The program removes some slight limitations in speed and in certain flight attitudes which existed before the aircraft were modernized. The larger tail (AW April 8, p. 120) and the "buzz fix" on the air inlet ramp also improve the stability of the aircraft.

Test Equipment

F-102As come to Convair-Ft. Worth loaded with test equipment for the various programs they were assigned to when they left the factory. Convair removes all this test gear—telemetering equipment, recorders, strain gages—and puts the aircraft through a program designed to produce an aircraft similar to the latest production model.

Test-to-Tactical program is very similar to the SAMSAC program recently phased out at the Convair-Ft. Worth plant.

In SAMSAC, Convair modernized B-36s to keep them on a par with the last production version.

Installation of a new tail is the major structural change in the Test-to-Tactical program.

The old tail is completely removed, leaving only the spars which are cut off 22 in. above the fuselage. Shortened spars in the new tail are then spliced on to the old spars, giving the F-102A a new tail which is 36¼ in. taller than the old one, including Fibreglas tip for antenna.

The new tail includes a larger rudder and larger air brakes. Air brake surfaces are about 40% larger than the older version, and the brake now sends a signal to the automatic flight control system which momentarily raises the elevators, correcting a tendency for the nose of the F-102A to drop when the air brakes are opened.

Some beefing of the aft fuselage is done to handle the stresses and strains of the larger tail assembly, including

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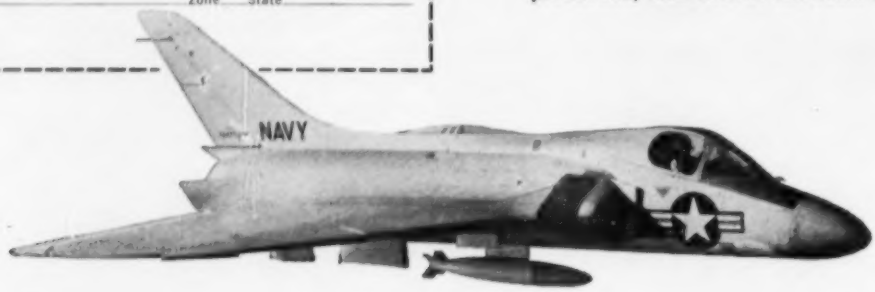
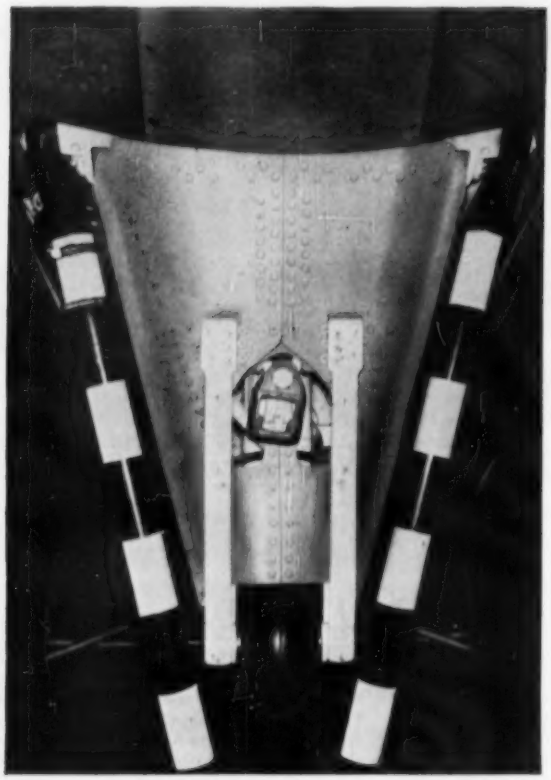
Armco 17-7 PH Stainless Cuts Costs, Saves Time in Production of Parts for F4D

Combination of strength and formability speeds production, cuts cost of tail beam skin on Skyray.





Since it set a world speed record in 1953, the Douglas-designed supersonic Skyray has proved itself in active Navy service. And recent modification of this sleek delta-winged carrier interceptor has demonstrated the advantages of Armco 17-7 PH Stainless Steel in the design and production of faster-than-sound aircraft.

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Originally the skin of the tail wheel beam on the F4D was made of 4130 steel. By switching to 17-7 PH, Douglas engineers gave the part added strength at high temperatures and made substantial savings in both production time and costs. Excellent formability and low temperature hardening of Armco 17-7 PH greatly reduced distortion . . . eliminated much costly straightening after heat treatment.

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use of bigger rivets and additional clips and brackets.

Buzz fix is designed to remove a high frequency noise which has bothered F-102A pilots. Air inlet ramp is moved forward a few inches, removing the noise from the cockpit area. The buzz fix helps buffeting problems under certain conditions, but it is mainly a noise fix.

Missile Doors

Missile bay doors are modified to handle a 2.75 in. rocket in place of the older 2 in. model. Exhaust deflectors are added to carry off rocket gases. F-102A can carry Falcon missiles, rockets or both.

The aircraft gets a new radar bay to handle additional equipment. The F-102As come in with the Hughes MG-3 system.

This is modified, and some equipment is added so that it provides three additional modes of operation, making it an MG-10 system.

Early production models of the F-102A go through the program for modernization of their armament and fire control system. And the old Hughes flight control system is replaced with a newer, more advanced system that is closely integrated with the radar and fire control systems.

Test-to-Tactical program is providing the F-102As with fittings under each wing to accommodate external fuel tanks.

These fittings have also become standard on production F-102As, and the wing tanks will be used for long range ferry missions.

Starter system in the F-102A is changed in the modernization program, replacing the old air-driven starter with a combustion-type for easier starts. Some operational F-102As have had trouble with fires in starting.

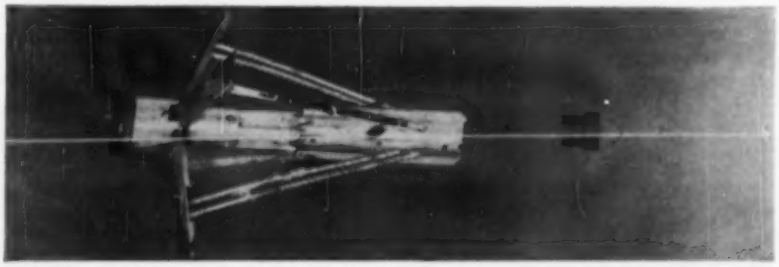
Major Inspection

Most of the aircraft going through the program are near a major inspection, and this is done as part of the Test-to-Tactical program. If a F-102A comes in with a J57-41 engine, it is removed and replaced with the J57-23, which is the current production engine, and old afterburners are replaced with later models.

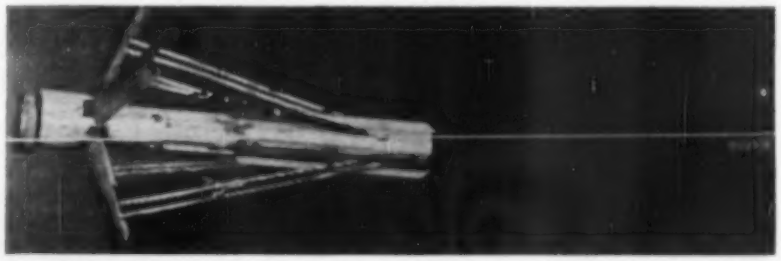
Test-to-Tactical program changes the interceptor to a liquid oxygen system for the pilot, and an emergency manual external release for the canopy is installed.

The F-102As arrive at Ft. Worth for the modernization program with all kinds of paint jobs, depending on the bases and programs to which they have been assigned. Convair removes all paint and gives them the standard Air Force gray paint job with standard insignia.

TWENTY-EIGHT INCH LONG cylindrical projectile carries the ICBM nose cone model out of the five-in. gun (not shown, 8 ft. to left) in an ICBM test methods development project by the GE Missile and Ordnance Systems Dept., Philadelphia, Pa. The dotted "nose" of the nose cone was added by Aviation Week's artist. Note remnants of muzzle blast behind cylinder.



NOW 70 FT. from the muzzle, the drag brakes have been popped and separation between model and cylinder accomplished. Note the springs which caused the drag brakes to pop. Velocity is approximately Mach 2.0.



NINETY-SIX FEET from the muzzle, the drag brakes have noticeably slowed the 40 lb. cylinder down while the 3½ in. diameter nose goes on in free flight ahead.

Nose Cone Vehicle Tests Planned

Preparations for a series of free flight model tests of ballistic missile nose cones have begun by General Electric's Missile and Ordnance Systems Dept., Philadelphia.

Tests will be conducted at NACA's Pilotless Aircraft Research Station, Wallops Island, Va.

Part of the GE preparation has included development of boost missiles which will separate from the nose cones after they have been boosted up to test speeds. A simple way to achieve this separation is by popping hinged drag brakes, restrained by nylon ropes, into the airstream. Sequence photos showing the results of a feasibility study of this method were made by GE at the ballistic firing range, Aberdeen Proving Grounds, Md.

The five inch diameter model of the test set-up was fired from a special gun and the result recorded by a series of cameras along the trajectory.

In the actual free-flight tests at Wallops, one of the boost missiles developed for Mach 10 and above by NACA (AW Mar. 11, p. 51) would be substituted for the five-inch gun. The nose cone model will be over one foot in diameter, large enough to house the equipment to telemeter back information on temperature, pressure and noise. With these tests, GE will be able to obtain more realistic data on the surface conditions on the afterbodies of its nose cone designs.

Though it has been possible to obtain laboratory information on nose cone forebodies, free flight tests are needed for the afterbody. In shock tunnels the interference of the tunnel side walls and the presence of the mounting sting have prevented GE from learning about

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afterbody flow. The limited diameter and concentrated nature of the plasma jet "flame" has made interpretation of its results for afterbodies tenuous at best.

GE would not elaborate on the types of free flight firings planned at Wallops. It was not stated whether the drag brakes would be sprung on the way up or whether the boost missile would send the nose up above the earth's atmospheric layer to simulate re-entry from true ballistic missile heights.

The nose of the nose cone model used in these Mach 2.0 preliminary tests has been retouched out to show a flat "sawed-off" shape. The object which remains has had a typical blunted cone shape dotted in by AVIATION WEEK's artist.

Though it would appear that the reduced diameter of the afterbody is a mechanical convenience for socketing the nose cone into the main missile, a GE spokesman said that this step down in diameter aids in nose cone stability by providing a flow separation point. Obviously it is important that the afterbody of such a shape steer the blunt heat resistant nose directly into the atmosphere upon hypersonic re-entry. Though spin stabilization or auxiliary control rockets might be used to keep the blunt nose pointed forward, a nose cone expert has told AVIATION WEEK that the short stepped down diameter afterbody is able to keep the nose cone properly steered. Other nose cones have had tapered afterbodies after the diameter step-down so that they resemble stubby, overpacked ice-cream cones. It is possible that these top-like shapes have purposely been used to cause the nose cones to wobble and distribute the re-entry heating over a larger surface.

Afterbody noise is being studied because the high frequency pressure fluctuations caused by afterbody turbulence has been found to affect both internal electronics and to cause fatigue of the surface materials.

U. S., Canada Join In Defense Staff

Washington—New joint U.S.-Canadian staff to integrate air defense operations and planning will be set up at Colorado Springs, Colo.

Gen. Earl D. Partridge, Commander of USAF Continental Air Defense, will head the staff. His deputy will be Air Marshal C. Roy Slemon of the RCAF.

Work of the new command will be confined to operational control of air defense forces in North America and the preparation of joint plans and procedures.

USAF said the program will have no effect on the selection or procurement of equipment. Present cooperation, under which aircraft as the F-86 is built under license in Canada, will be continued.

Warheads of Glass Arm Nike Hercules

Azusa, Calif.—High explosive warheads with bodies made of glass fabric annealed with resin are being produced for Nike Hercules ground-to-air missiles by Aerojet-General Corp. under a $1,846,500 Air Materiel Command contract.

Aerojet designed, developed and tested the warhead, which it said embodies new principles of fragmentation as well as construction. Use of glass materials and techniques not used for this purpose before allowed considerable savings in weight.

Nike Hercules has nuclear capability but apparently will be in inventory in high explosive configuration. Former Aerojet liquid propellant main engine in Nike Hercules has been changed to a Thiokol solid propellant motor to eliminate storage and handling problems. Thiokol also makes booster motor for Hercules. Aerojet continues to make the liquid motor for Nike Ajax.

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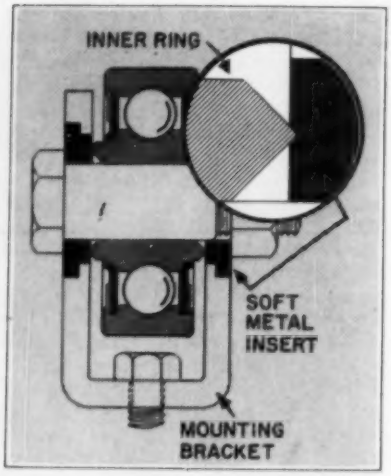

Bearing Development Reduces Looseness

Aircraft ball bearing development which cuts any radial looseness due to clearance between bolt and hole in the inner race is being incorporated by The Fafnir Bearing Company on units being used on Convair's B-58 Hustler supersonic bomber.

Convair needed a control system that was as tight as possible and with little or no play. To help achieve this goal, Fafnir developed a series of ball bearings on whose inner rings were machined sharp, wedge-shaped edges concentric with and slightly larger in diameter than the bolt hole. The sharp edges extend outward and dig into soft metal inserts in the bearing mounting bracket as nuts are tightened down on the bearing support bolts, thus eliminating any slope between bearing and bracket.

Design is used when radial movement of mounted bearing must be at a minimum as in low-friction control systems using push-pull rods or wire linkages.

Japanese Kappa 3 Reaches 2,420 Mph.

Tokyo—Two-stage rocket—the Kappa 3—has been successfully test-fired, paving the way for formal triggering of the supersonic Kappa 4 rocket in the International Geophysical Year observation program.

The Kappa 3, fired from Michikawa Beach in Akita Prefecture, northern Honshu, toward the Japan Sea, climbed to a height of 71,500 ft. with a maximum speed of 2420 mph. The rocket is 16.5 ft. long weighs 374 lb.

Experts of Tokyo University's Institute of Industrial Science who fired the Kappa 3 believe the more advanced Kappa 4 will be able to reach an altitude of 192,000 ft. traveling at speeds up to Mach 5.

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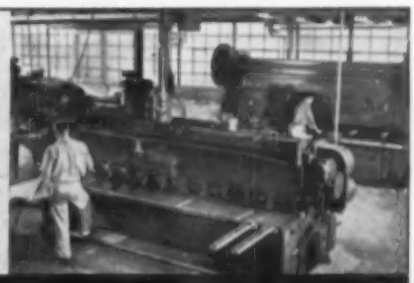

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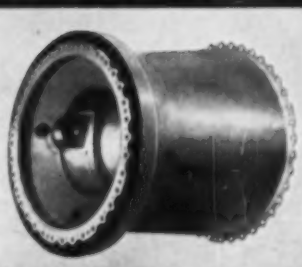

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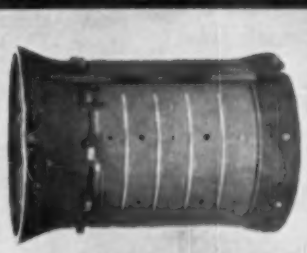

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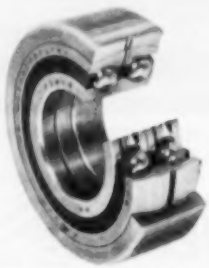

This Fafnir Super-Precision Ball Bearing for main rotor shafts of jet engines involves a standard radial and an angular contact bearing assembled in a one-piece, self-aligning outer ring.

Skill and knowledge and experience, especially experience, are deciding factors in prompting aircraft designers to turn to Fafnir for help in solving bearing problems. Through continuous research plus collaboration with aircraft design engineers for nearly 30 years, Fafnir keeps in step with aircraft developments . . . and produces bearings to meet the needs. Super-precision jet engine bearings are typical examples. The demand for these Fafnir "specialties" has skyrocketed. The Fafnir Bearing Company, New Britain, Conn.

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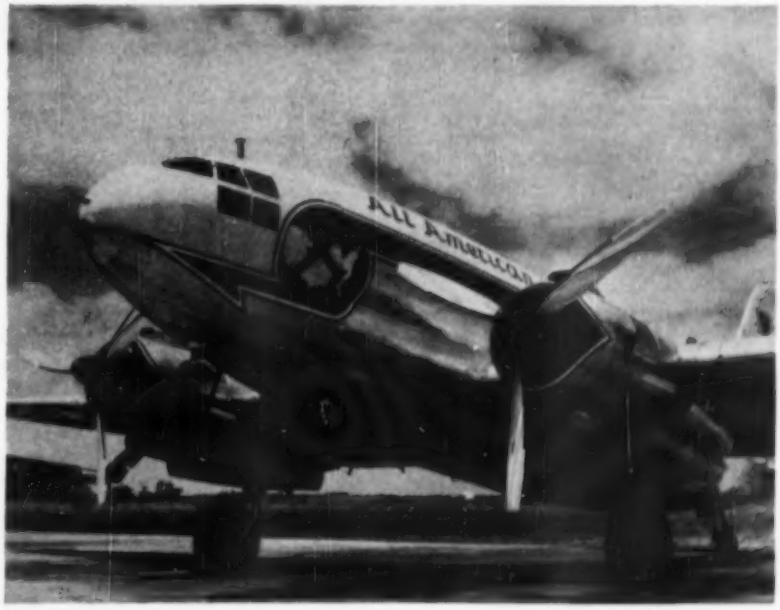
C-46 Changes Begin to Meet CAB Ruling

By Craig Lewis

San Antonio—Long-awaited modification of the C-46 to meet Civil Aeronautics Board requirements is finally getting under way as C-46 operators begin large scale installation of Super 46 modification kits developed for them by the Aircraft Engineering Foundation.

Howard Aero Service has launched an installation program for C-46 operators here at San Antonio International Airport, and several airlines are installing their own in an effort to remove the stigma of CAB deadlines which have been hanging over their heads for four years.

FIRST production modification from C-46 to Super 46 was done by Howard Aero Service for All American Airways. Changes are smaller cowling, new propeller spinner, external air scoop on nacelle top for carburetor and on bottom for oil cooler, and the augmentor tubes from the exhaust system protruding at an angle from the sides of the nacelles (below).



Kit Prices

Aircraft Engineering Foundation has engineered a kit which meets the CAB's requirements and which was certificated in April, 1956. Thieblot Aircraft Co. manufactures the kits, and they are sold through the foundation for $32,500 to members and $37,500 to nonmembers. Howard is charging $16,000 to install them.

Basically, the Super 46 enables the airplane to meet modern fire prevention and fire extinguishing requirements, and it improves performance by recovering power lost through shortcomings in the standard C-46 engine installation.

Foundation has secured a supplementary certificate covering all existing C-46 models A, D, E and F. Present certification will accommodate either the R2800-B or the R2800-M-1 engine.

L. B. Smith Aircraft Corp. of Miami is currently in the midst of a program to certificate the Super 46 kit for the R2800-C engine. When this version of the kit is certificated, L. B. Smith will have exclusive sales rights to it.

Other Modifications

Before getting into the Super 46 program, L. B. Smith had sold several CW-20Ts, a more ambitious and more expensive modification of the C-46. Riddle Airlines has also developed a modification designed to bring the C-46 to CAB requirements.

Foundation Super 46 kit is available to any C-46 operator. Although Howard Aero has turned out the first production installation and is working on more, kit purchasers are free to install it themselves or have the job done by any fixed base operator they choose.

Major problem on the C-46 is inadequate engine cooling, especially in emergency conditions. Kit solves this problem with a number of changes, including a smaller cowling, a new propeller spinner and a new exhaust system.

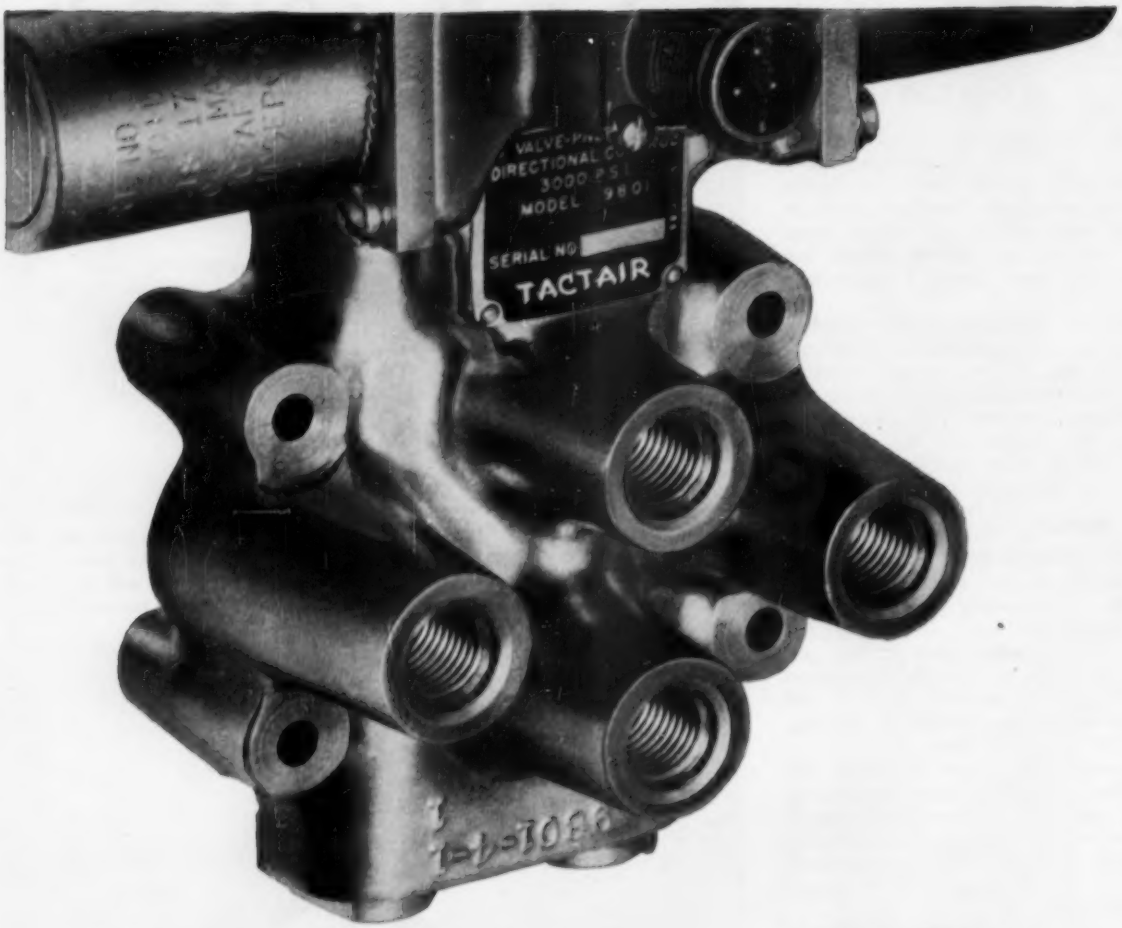
New cowling is round with external air scoops for the carburetor and oil cooler in place of the standard egg-shaped cowling with its built-in air scoops. New cowling, with the new spinner and afterbody, is designed to provide the correct amount of cooling air to the cylinder banks in a streamline flow.

Once the air passes over the cylinders, a new augmentor exhaust system provides a suction effect to continue the streamline flow. The augmentor system uses augmentor tubes with Siamese exhaust stacks in place of the old collector ring system. Life of the augmentor system, made by Ledkote Co. to Foundation specifications, is estimated at 5,000 hr., compared with the 1,000 hr. life of the old exhaust system.

New air scoop on top of the cowling for the carburetor system eliminates the tendency of the old built-in scoop to stall out at higher angles of attack. It also increases the optimum cruising altitude nearly 1,500 ft.

Similar problem with the oil cooler scoop in the old nacelle is solved by installation of an external scoop on the bottom of the new cowling which gives a constant flow at all angles of attack.

Another major problem with the airplane has been inadequate fire protection. Super 46 kit solves this prob-



Note: to precision-minded men at MARTIN

It's one thing to design valves of unusually light weight —another to engineer them for high reliability under extraordinary conditions. At Tactair, we've learned to do both, not occasionally, but consistently. Result: a growing recognition among leading airframe designers that they can entrust their toughest valve problems to Tactair.

Case in point: this 4-way, solenoid-operated, pneumatic selector valve for a rocket release mechanism. To assure its rapid, dependable operation over a wide range of operating pressures, we combined a number of tried and proved design principles used individually in other models. And to minimize weight, we made the valve a pilot-operated unit.

Result: an uncommonly wide pressure range of 500 to 3,000 psi at altitudes from sea level to 70,000 feet. Extremely high flow capacity for a valve this size—actual flow factor of .2 Qu. Low leakage—3 cc per min. of free air. Rapid operation—.05 sec. max. (energized). And with this, a weight of only 1.9 lbs.

Reminder: on standard or special components, we welcome the opportunity to assist you with your next precision valve problem. Every job we do is done on a personalized basis. It has been that way for 16 years. Tactair Valve Division, Aircraft Products Company, Bridgeport, Pa. BRoadway 5-1000.

CONTROL, SELECT, BRAKE, RESTRICT, CHECK... with TACTAIR®

lem with new fire detection, extinguishing and protection systems.

A secondary firewall is installed between the engine and the accessory section in the nacelle. This provides a sealed accessory section zone. In the first zone, such critical areas as the exhaust system, the secondary firewall, ducting for the oil cooler scoop and the shrouds are stainless steel. Zone 2, the accessory section, is completely compartmented with stainless steel.

Third zone, the wheel well compartment, is protected with stainless steel sheeting on the wheel well doors.

Lower Temperatures

Howard Aero found that nacelle temperatures in their first kit installation were lowered considerably. Takeoff temperature of the cylinder heads is 220 deg., compared with 250 deg. on the standard C-46. Cruise temperature is 175-180 deg. substantially lower than the old range of 210-215 deg.

These new lower operating temperatures, and isolation of the various nacelle zones with stainless steel, add significantly to the fire protection capability of the modified C-46. Howard also points out that protection of accessories and lines from heat reduces maintenance cost on the engine forward of the firewall by about 25%.

New fire detection and extinguishing systems were designed by the Foundation. Individual dual warning lights for all three nacelle zones are installed on the instrument panel along with a master fire-warning bell. Fire detectors operate on both rate of rise and maximum temperature.

Each nacelle has a new high discharge, two-shot extinguisher system built to Foundation specifications by Walter Kidde & Co., Inc. Agent is bromorifluoromethane, and the system will absorb oxygen eight times faster than CO_2. It is also less toxic than CO_2, and the new system is 310 lb. lighter than the current CO_2 system.

Ground Handling

Hytrol Anti-Skid Brake System is installed to improve braking and ground control handling qualities of the C-46. Super 46 is the only tail wheel aircraft certificated for this braking system.

Hydraulic system is modified to make both the brake and main accumulators accessible to the gear retractor during takeoff. This reduces retraction time to 11 sec. from the former time of 19-21 sec.

Automatic power loss indicators are installed on the instrument panel next to the corresponding feather switches to help the pilot determine whether an engine should be feathered in a partial failure. All emergency controls are centrally located on the panel to promote more rapid emergency procedure.

As the Foundation's president, Monte H. Snedeker, points out, improvements in the transport's safety and performance come from the application of numerous engineering improvements well within the state of the art, rather than from any new technical breakthrough.

Improvement in performance comes from a number of factors. Changes in the nacelle area allowed Foundation engineers to recover about 250 hp. in each engine, and the new cowling reduces flat plate drag about 1.8 sq. ft. Faster gear retraction reduces drag and improves takeoff performance. Rate of climb increases about 38%.

Super 46 kit increases cruise speed 12-15 mph. to about 212 mph. Gross weight with the R2800-B engine is 47,100 lb. and gross for the M-1 engine is 47,400 lb.

Kit Installation

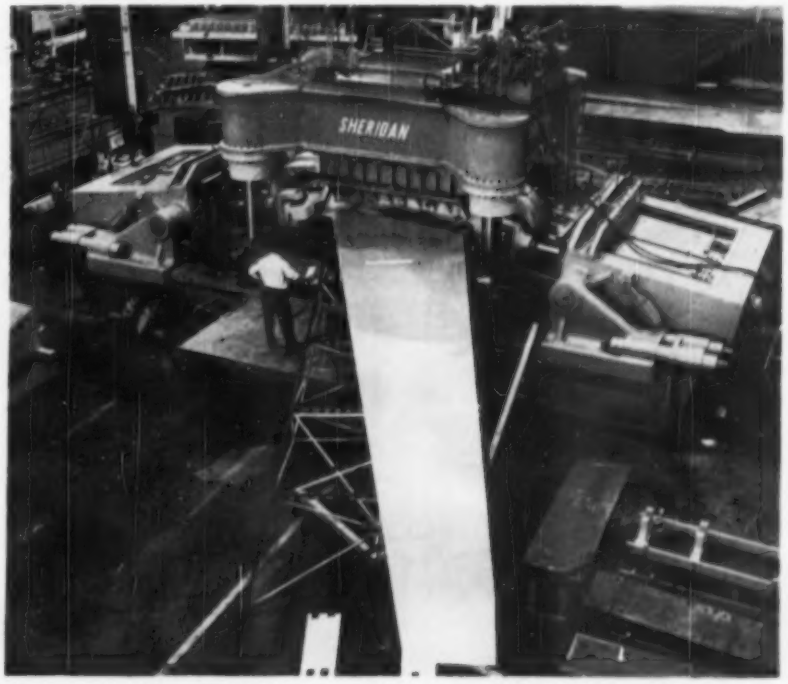
First production installation was made by Howard Aero on an All American Airways C-46 which was certificated June 28. Howard has modified a second All American ship, has commitments for two more from All American and one from Westair. Other contracts are under negotiation.

According to Jack Brink, Howard's foreman in charge of air carrier maintenance, the Super 46 kit reduced empty weight of the first All American ship from the normal C-46 average of about 32,000 lb. to 30,512 lb. Combined with a higher gross, this means a net gain of about 3,500 lb. available for passengers, cargo or fuel as the operator chooses. More fuel capacity means greater economy because fewer stops are required, and added passenger capacity means more revenue.

Operational Test

Foundation's Super 46 prototype was operated in the Flying Tiger Line system for eight months to test its economic aspects. During this period of scheduled cargo service on the Burbank-San Francisco-Seattle run, the Super 46 operated at a block-to-block speed of 189 mph., compared to 178 mph. for three standard C-46s operated in the same pattern. In 1,200 hr. of operation in the Tigers' pattern, Super 46 direct operating costs were $10.71 per hour less than those of the standard C-46.

Development of the Super 46 kit



Stretch Press Forms DC-8 Skin

DC-8 commercial jet wing skin is formed in large 4-directional stretch press at Douglas Aircraft, Long Beach, Calif. The Sheridan stretch press, desribed as the largest of its kind in world, is being used to form single piece wing skins from 10x50 ft., 1,200 lb. aluminum plates. As shown, retention clamps cross-wise to the sheet hold the skin while the jaws on the right and left draw the skin down over a stretch die which rises under the skin to form a dihedral contoured angle. Holding fixture in the foreground supports the aluminum plate which has been tapered from 0.230 to 0.135 in. before delivery. After forming, the part is oven aged, cleaned, surface treated and painted before going into the DC-8 wing assembly.

Bendix Synchro "Supermarket" also headquarters for RADAR ANTENNA DEVICES

Doubtless you've learned to depend on the Bendix Synchro "Supermarket" for fast delivery and tremendous selection of precision synchros, servo motors and other vital electronics systems components. But did you know that Bendix is also a prolific producer of radar antenna devices?

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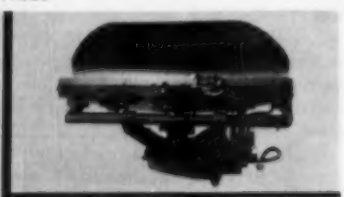
TYPICAL EXAMPLES OF BENDIX RADAR ANTENNA DEVICES

Lightweight, ground-based, air-transportable tracking antenna pedestal for mounting 8-ft. diameter, s-band segmented parabolic reflector and nutating scanner; highly accurate 2-speed data systems in elevation and azimuth.

Lightweight, ground-based, air-transportable, dual reflector, multi-band, high gain search antenna and control system; 2-speed data systems and magnetic clutch drives in azimuth and elevation.



Airborne reflector mounting and drive unit for x-band antenna; 2-speed, continuous rotation in azimuth, either direction; 40° and 60° sector scans; remote manual tilt; line of sight stabilization.

Airborne weather radar antenna with line of sight stabilization for x- or c-band; switchable wide fan (cosecant squared) beam pattern for mapping or pencil beam for storm detection.

Eclipse-Pioneer Division
TETERBORO, N. J.

Bendix
AVIATION CORPORATION

grew out of regulatory action taken by the CAB four years ago after the Board had taken a look at the C-46's accident record. Special regulation was issued requiring that the transport meet transport category standards in order to be eligible to carry passengers. Extensions have been granted since then, and the operators have been flying the aircraft under waivers until a satisfactory modification became available.

When the CAB clamped down in 1953, C-46 operators got together and formed the Aircraft Engineering Foundation. Foundation President Snedeker's job was to find ways of bringing the transport up to CAB's new standards.

Safety Record

When the Foundation launched its program in 1953, the C-46 safety record was under fire. The transport had been manufactured during World War II for the military. After the war, surplus C-46s were turned loose for civil operation without the normal engineering help and guidance customarily provided by the manufacturer of a commercial transport.

Looking over this safety record, the Foundation discovered that 68% of the accidents had been caused by a lack of pilot training, and another 20% were traced to poor maintenance. These were shortcomings which could be corrected without modifying the airplane, so the Foundation launched a four point program to cover all aspects of the C-46 situation.

This program committed the Foundation to (1) improve operating standards of the C-46, (2) improve maintenance, (3) develop a modification kit, and (4) act as technical sponsor of the transport.

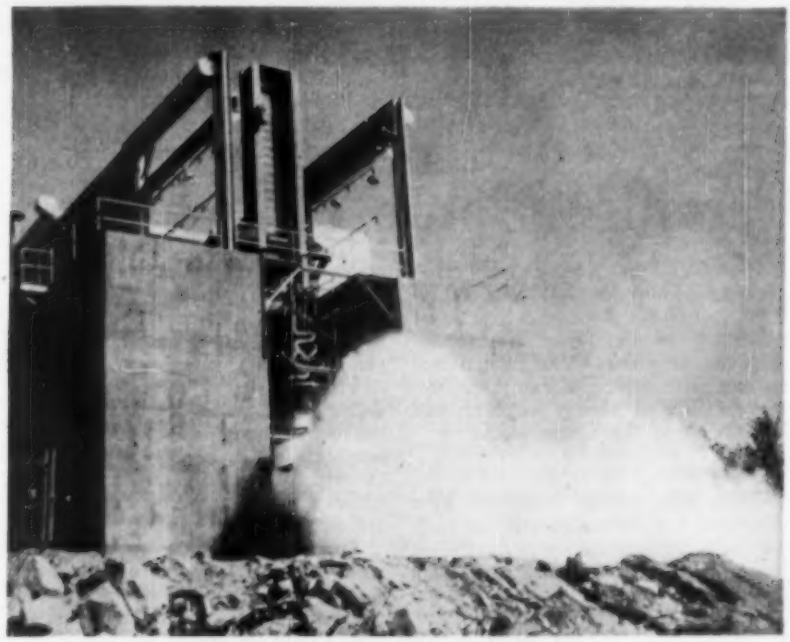
To solve the pilot error problem, the Foundation joined the CAA in a program conducted at Oklahoma City between September, 1953, and June, 1954. In this program, C-46 pilots went through a two week course designed to train them in the proper emergency procedures for the airplane.

As a measure of the success of these efforts, Snedeker points out that there have been only two fatal accidents with the C-46 since September, 1953.

Fifty Kits Sold

Work on a modification kit for the C-46 was started in 1953, and a certificate was issued by the CAA on April 6, 1956. Fifty of the kits have been sold by the Foundation, and about half of them have been delivered.

With the design and development of the Super modification kit out of the way, the Foundation continues to pursue its role as technical sponsor of the airplane. Service bulletins are issued as problems come up, and the Foundation does a continuing job of providing a factory-type technical service for C-46 operators.



Stand to Test X-15 Engine

Reaction Motors Inc., built this test stand at Lake Denmark, N. J., capable of testing rocket engines in the million pound thrust class in any flight attitude. It will test the 60,000-lb. thrust engine for North American X-15. Engine systems for test, including tanks, are mounted on a large rotating beam which can be raised or lowered by hydraulic cylinder.

■ TUBING in industry varies in application so widely that the word QUALITY can be misinterpreted easily. Not so with PERFECTION! When the chips are down and safety, performance, and LIVES are on the line, the kind of tubing TMI makes proves itself worth all the care and tedious quality-control that precision specifications demand.

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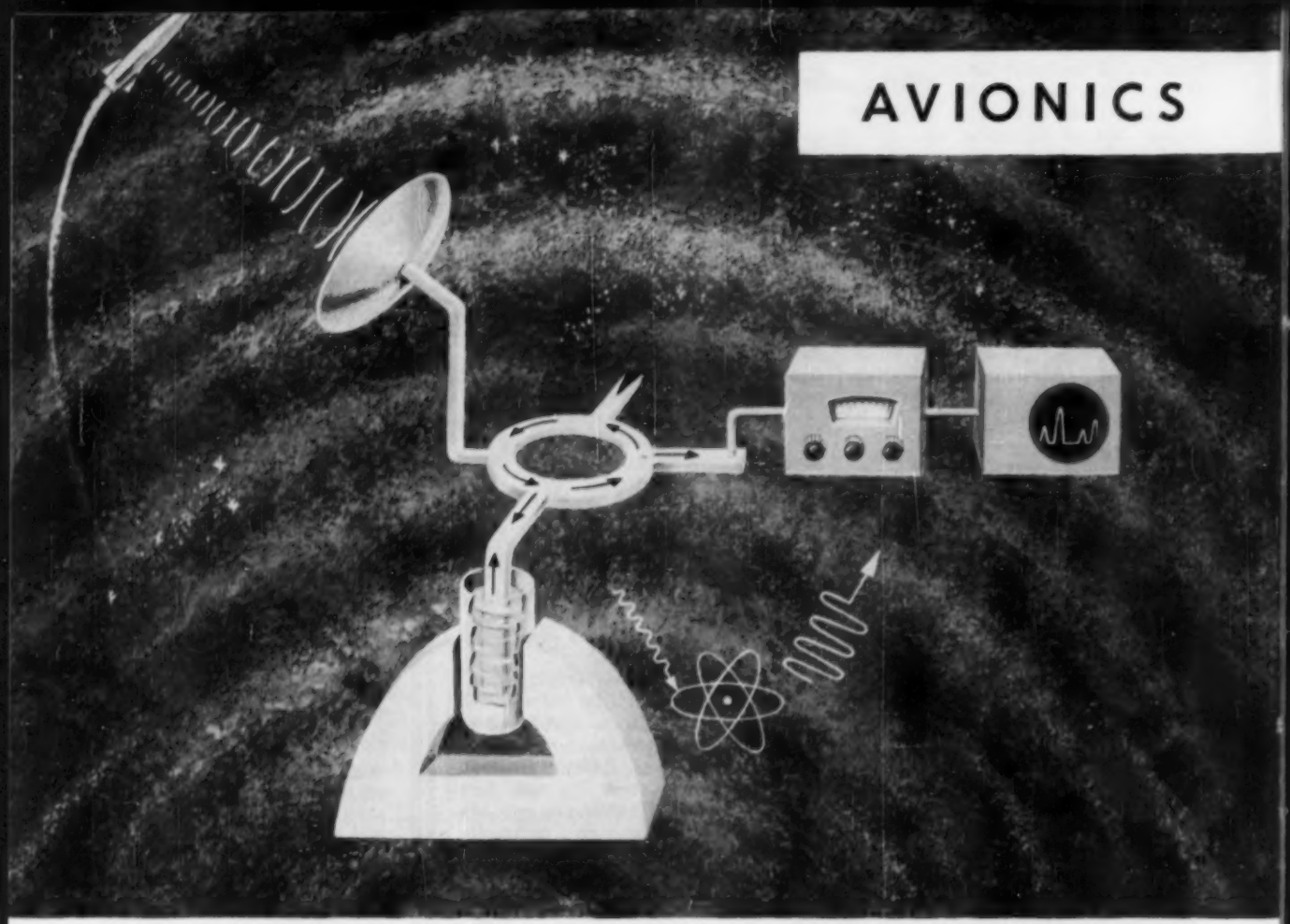


LOW NOISE CHARACTERISTIC of atomic amplifiers can be used to extend the range of missile and satellite tracking radars as indicated pictorially above. Conventional Maser is shown at bottom of the diagram.

How the Maser Operates: Part I

Maser Shows Promise, Some Drawbacks

By Dr. Richard W. Damon

Recent developments in atomic physics have produced an entirely new type of high frequency amplifier which holds promise of great gains in the range and performance of radar, electronic countermeasures and scatter communication systems. Another application of the same principles is the atomic clock, an oscillator with remarkable frequency stability (AW Oct. 22, 1956, p. 103).

The term Maser frequently is applied to the new devices. This is an acronym derived from their principle of operation, i.e. Microwave Amplification by Stimulated Emission of Radiation.

The name sometimes is applied to a very recent development in atomic amplifiers which use ferrite or garnet material. In a strict sense, this newer device is not really a Maser because its operation is based on somewhat different principles—principles not yet understood as fully as those of conventional Masers. However, these newer ferromagnetic amplifiers have operational characteristics which in many ways resemble those of Masers and both will be covered in this discussion.

Low Noise

These new atomic amplifiers have generated tremendous interest in military and industry circles primarily because of one characteristic extremely low noise.

Ultimate sensitivity of any radar, communications or countermeasures receiver is set by the noise level of the input stage. Noise level of atomic amplifiers can be as little as 1/1,000 that of presently used klystrons and traveling wave tubes. The reason is basic: conventional tubes operate by virtue of electron flow, itself a cause of noise. The atomic amplifier uses no electron flow, extracts internal energy from uncharged atoms.

The solid state atomic amplifier, consisting of a small crystal mounted in a microwave cavity and exposed to a magnetic field and source of microwave energy, is basically less complex and ultimately should be less costly than traveling wave tubes or klystrons.

The devices provide attractive bandwidths, some as high as several hundred megacycles. They are electrically tunable and can be designed for frequency ranges from 100 mc. to 100,000 mc.

These advantages are not obtained without certain penalties. For example:

• **Extremely low-temperature operation.** Most atomic amplifiers, such as the Maser or (as it is also known) para-

magnetic amplifier, must be operated at near absolute-zero (−273C) temperatures, which requires heavy, costly cryogenic equipment. This tends to limit their use to ground based systems. However, the recently developed ferromagnetic amplifiers can operate at room temperature and higher, although cooling does improve their performance.

• **Low power capability.** Most atomic amplifiers developed so far have relatively low power outputs of about a fraction of a watt. (Amplifying properties are destroyed at higher power levels.) Atomic amplifiers may therefore be used primarily as preamplifiers with conventional microwave tubes employed for output stages. Here again, however, ferromagnetic amplifiers may overcome these power limits.

• **Low noise design.** Extremely low noise level of the atomic amplifiers increases system design problems because all other sources of noise within a system, particularly ahead of the atomic amplifier, must be minimized to realize full advantages of the device.

Hardware Emerging

The atomic amplifier has just begun to move out of the laboratory into hardware development, but intensive research work is continuing. Principles of operation have been established and the feasibility of building useful devices has been experimentally demonstrated.

One indication of the current interest in atomic amplifiers is the number of companies and research facilities now active in the field. These include: Air Force Cambridge Research Center, Bell Telephone Laboratories, California Institute of Technology, Columbia University, General Electric, Harvard, Hughes Aircraft, Lincoln Laboratory, Massachusetts Institute of Technology, Princeton, Radio Corporation of America, Stanford University, Varian Associates and Westinghouse Electric.

Out of these widespread research and development efforts could come entirely new types of atomic amplifiers, some of which may be suitable for airborne equipment, much as the original transistor invented in 1948 has spawned a vast family of semiconductor devices with far greater versatility and usefulness than the original.

The familiar sodium street-light illustrates some of the fundamental properties of atomic systems similar to those used in the Maser. In both, an external source of energy is used to excite the system of atoms. The atoms release this absorbed energy in the form of electro-magnetic radiation whose frequency is characteristic of the particular atoms used. In the sodium lamp, the atoms receive energy from an electric arc and give it off immediately as yellow light which corresponds to the characteristic frequency of the sodium atoms.

Author of Exclusive Series

Atomic amplifier, or Maser as it is sometimes called, is one of the most significant developments of the post-war period, comparable to the discovery of the transistor nine years ago. In its principles of operation, the atomic amplifier differs radically from the vacuum tube or transistor, making use of electron spins within the atom itself.

This article is the first of a two-part series intended to give Aviation Week readers an understanding of the operating principles of the new atomic amplifiers and some of their remarkable potentialities as well as their limitations.

The author, Dr. Richard W. Damon, is a physicist in General Electric's Research Laboratory, currently engaged in research in the field of magnetic resonance phenomena and their application to atomic amplifiers. During the author's doctoral investigation on ferromagnetic resonance, at Harvard, he discovered the non-linear behavior of ferromagnetic materials which forms the basis for operation of one of the newest types of atomic amplifiers.

In the Maser, energy also is fed into atoms constituting the heart of the device. But the atoms in materials used for Masers have a characteristic frequency that is below the visible light spectrum. There is another, and crucial difference between the Maser and the sodium lamp: the Maser atoms do not radiate the excitation energy spontaneously as sodium does.

The Maser requires a second source of excitation which must be applied at the characteristic frequency of its atoms. Under such conditions the energy stored in the atoms is released at this characteristic frequency, adding to the strength of the signal radiation and thereby amplifying the signal.

Thus, the three basic properties required for Maser operation include:

• **Source of energy.**

• **Characteristic frequency** of atoms in material used must lie within range of frequencies at which amplification is desired.

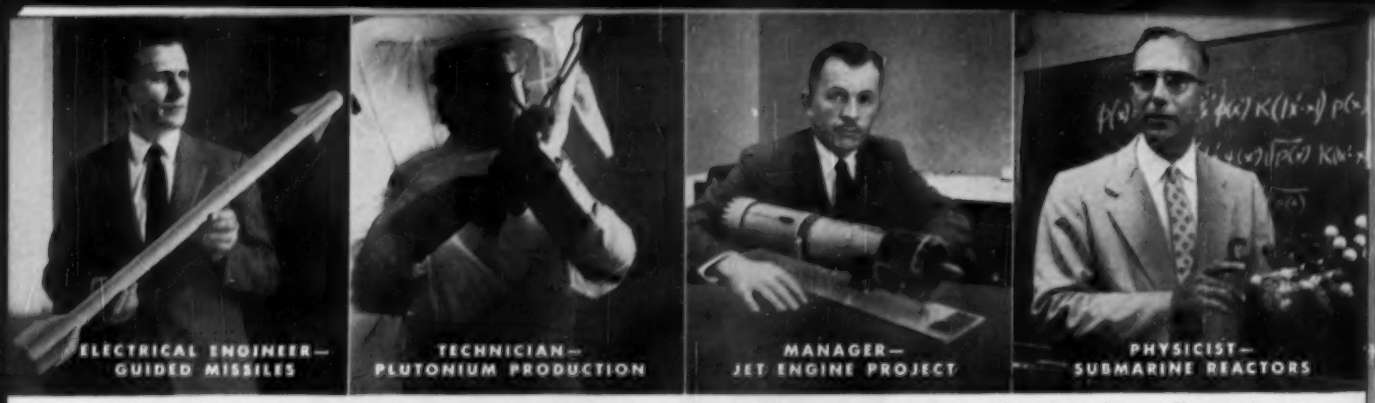
• **Energy must be stored** in atoms until emission is stimulated by radiation at their characteristic frequency.

Basic principle of Maser operation can be illustrated by the use of a mechanical analogy. The particular system described is a pulsed solid-state device using a paramagnetic salt, but with minor changes the same model could be used for the gaseous type or for CW operations.

Electron Spin

About 30 years ago scientists discovered that electrons, in addition to moving in fixed orbits about the nucleus, also spin about their own axes. This causes the electron to behave much like a small gyroscope and many of its properties can be explained using the classical theory of gyroscopes.

However, the electron is more complicated than a gyro. In addition to its spin, the electron also has an electric charge. This spinning charge is equivalent to an electric current. Since every electric current produces a corresponding magnetic field, the spinning electron behaves like a small magnet



Devoting the talents of outstanding people. Staying ahead of potential aggressors requires quality of people as well as equipment.

How General Electric is trying to help meet the increasing challenges of defense

Today Americans are being forced to think in a totally new way about national defense. The United States can no longer expect to build military strength after an attack, but must be ready at all times to discourage aggression and maintain peace.

Yet, at the same time that a sizable portion of research, development, and production is constantly devoted to defense, we as a nation are striving to continue to advance our living levels.

Security with solvency

The resources of the nation are not limitless. Maintaining security with solvency presents a challenge to business and government to make sure that every citizen is getting the most for his defense dollar.

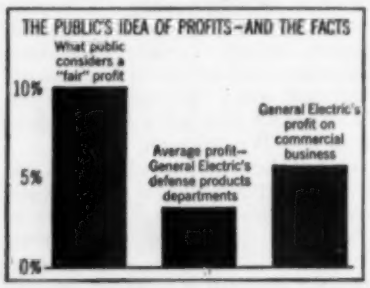
In helping meet this challenge, General Electric is:

- Devoting the talents of nearly half of the company's scientists, engineers, and technicians to defense activity.
- Bringing to bear its large-scale resources to pioneer vast and complicated defense projects . . . and then breaking down the big jobs into tasks to which thousands of other businesses contribute their specialized skills.
- Trying to conduct defense work as a business instead of an interruption of business.

Toward greater defense values

Meeting defense requirements is a continuing duty of responsible business. General Electric believes, however, that even fuller value from industry participation can be gained by infusing into defense work the same free-enterprise incentives that keep the civilian economy vigorous and able to supply good values to customers.

One way is to encourage maximum incentives for cost reduction in which both the taxpayer and the producer share in savings; another is to stimulate risk taking by making possible returns on defense accomplishments that warrant greater private investment.


THE PUBLIC'S IDEA OF PROFITS—AND THE FACTS
What public considers a "fair" profit
10%
5%
0%
Average profit—General Electric's defense products departments
General Electric's profit on commercial business

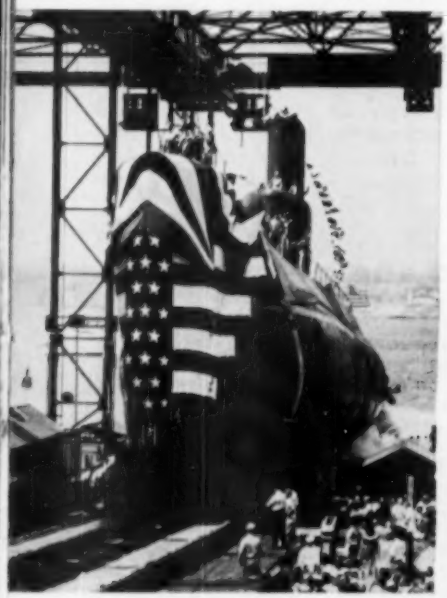
As General Electric sees it, fully utilizing the incentives of a free society will deliver to every citizen greater defense value for his tax dollars . . . and at the same time continue to provide Americans with the highest living levels anywhere in the world. 210-111

Progress Is Our Most Important Product

GENERAL ELECTRIC

To help further public understanding of key defense problems, this message is appearing in TIME, NEWSWEEK, U.S. NEWS, NEW YORKER, FORTUNE, ATLANTIC, HARPER'S, SATURDAY REVIEW, CHRISTIAN SCIENCE MONITOR and WALL STREET JOURNAL.

Nearly half of G.E.'s technical personnel is assigned to defense work, even though it is only about 20% of the company's total business.



Bringing to bear large-scale resources. Typical of complex jobs undertaken by General Electric is development of atomic reactors for submarines (like the *Seawolf*, above).

Mobilizing the skills of businesses of all sizes. In taking responsibility for complicated defense projects, and breaking them down into jobs smaller firms can handle, General Electric brings together the specialized talents of many businesses. Here are a few representatives of more than 800 firms which help General Electric produce large radar units.

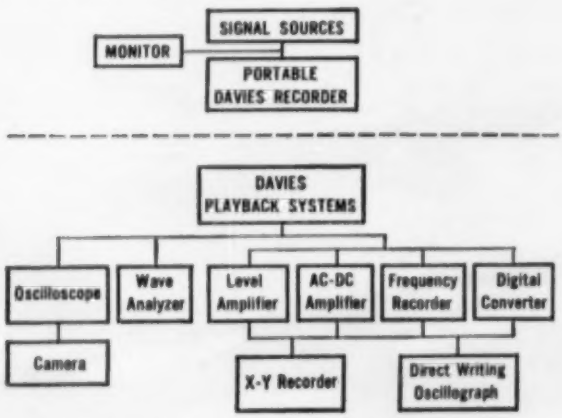
The revolutionary J79 jet engines powering the new B-58 supersonic bomber and F-104A fighter-interceptor were developed by General Electric. The J79 is the most powerful jet engine for its weight yet built.

General Electric Company's Charles A. Woodcock begins analysis of aircraft gas turbine operating dynamics by pressing "Start" button on one of two Davies Division magnetic tape systems at the Flight Propulsion Laboratory Dept. Data Reduction Center, Evendale, Ohio.

how G.E. data center analyzes dynamic jet engine operation

G.E. wants to know a lot of things about an aircraft gas turbine before it leaves the ground. Not just thrust, pressure, temperature . . . but vibration and stress characteristics too. While suitable equipment has long been available for recording and measuring the "static" operating characteristics, only the last five years have seen reliable techniques introduced for measuring, recording, and reducing significant information from dynamic signal sources.

A pioneer in the application of these techniques, General Electric's own dynamic data handling installation at the Flight Propulsion Laboratory Department, Aircraft Gas Turbine Division, Evendale, stands as one of the most complete in the country. Originally conceived by the Laboratory, the facility has contributed substantially to the outstanding progress of aircraft gas turbine design at G.E. Data recorded at the test site can be played back through two tape systems at the Laboratory into electronic data analysis equipment and analog and digital displays for a fast, detailed picture of gas turbine performance.



The substantial part played by magnetic tape in the system reflects its growing importance as the common denominator of dynamic data handling. Dynamic range and frequency range are several times greater than characterize other recording media, and the data is stored "live". The original electrical transducer signal can be accurately re-created whenever desired for observation and processing.

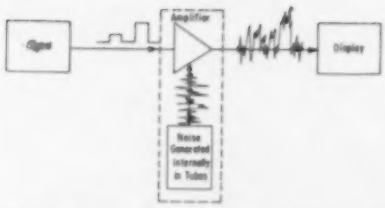
Five portable magnetic tape data recording systems are used by G.E. to collect data at the engine test cells. Signals ranging in frequency from DC to 30 kc, are recorded by Direct or FM carrier techniques. Wide 1¼" tape carries 28 tracks of data, plus reference frequencies, timing signals, and voice, as desired. Monitoring oscilloscopes permit visual observation of the recorded signals. It is interesting to note that the five *portable* recording systems were originally designed by the Davies Laboratories Division for the limited space and severe environments of aircraft flight testing. The strength built into them has proved invaluable to G.E. despite the fact that they have never been operated in the air.

With the completion of a test, the reel of tape is transferred to the data reduction center. Two complete Davies Division laboratory record-reproduce systems permit utmost flexibility in feeding tracks of data serially or simultaneously into reduction and display equipment. Oscilloscopes permit a quick look at results through rapid visual inspection; wave analyzers provide a record of frequency components; level recorders measure amplitude; direct-writing recorders and oscilloscope cameras permit a complete record of wave shapes and phase relationships.

Davies Division magnetic tape data recording installations as large and complex as this one at General Electric Company can rarely be outfitted with standard package equipment. But for the smaller installations, recently announced Davies Universal Magnetic Tape Systems are an ideal choice. You can get a good background in magnetic tape data recording techniques in general by requesting our Bulletin 1001. Universal Systems are covered in Bulletin 2701. Minneapolis-Honeywell Regulator Company, Davies Laboratories Division, 10721 Hanna Street, Beltsville, Maryland. Or call WEbster 5-2700.

MINNEAPOLIS **Honeywell**

DAVIES LABORATORIES DIVISION

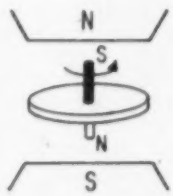


BLOCK diagram pictures distortion of incoming signal by noise.

attached to a tiny gyroscope. This model will be used to describe the basic principles of Maser operation.

Gyroscopic Action

If the gyro-magnet, representing the electron, were placed in an external magnetic field, like a compass needle it would seek to align its south pole (S) with the north pole (N) of the external field. (Fig. A) This is called the equilibrium position and corresponds to the lowest energy state for the system.



(a)

However, because the electron exhibits gyroscopic behavior, the torque exerted by the external field causes it to precess at right angles about the field. (See Fig. B.) The precession rate, like that of a conventional gyro, is determined by the applied torque and the angular momentum. For an electron, this works out to approximately 2.85 megacycles per gauss of field strength.

(b)

This precession rate corresponds approximately to the characteristic frequency of the paramagnetic atoms used in the Maser since the paramagnetism arises from one electron spin on each atom.

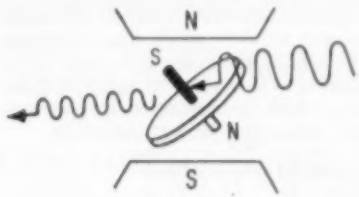
Thus a Maser operating area frequency of 100 mc. requires an external field of approximately 35 gauss, or 35,000 gauss for operation at 100,000 mc.

As the gyro-magnet precesses, it dissipates magnetic energy somewhat analogous to the way a conventional gyro immersed in a fluid experiences viscous damping. Most of this magnetic energy is dissipated in the Maser crystal in the form of heat; a small amount is given out as electromagnetic radiation at the characteristic frequency. Thus the gyro-magnet precession angle decreases until it returns to a state of equilibrium in which its north-south axis is aligned with the external magnetic field.

Energy Absorption

If a gyro-magnet in a state of equilibrium is exposed to a source of radio frequency energy applied at right angles to the external field, the oscillating magnetic field from the radio frequency source will exert an oscillating torque on the gyro-magnet. If the frequency of the radio frequency source equals the gyro-magnet's precession frequency, it will precess in synchronism with the oscillating magnetic field, absorbing energy from it.

This will increase the gyro-magnet's precession angle (from equilibrium position) until the power absorbed from the oscillating field just equals the power dissipated by the previously described damping mechanism. (Fig. C.)



(c)

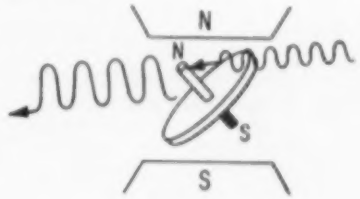
This is the process of resonance absorption by a system in equilibrium, a technique that has been applied to industrial analysis of materials. The process does not provide amplification because the gyro-magnet starts from a position of lowest energy and therefore has no excess energy to give up to the oscillating field.

Getting Amplification

If, however, the gyro-magnet can be inverted so that its south pole points toward the south pole of the external field then it will be in its highest energy state, an unstable one, and amplification can be obtained.

(Number of different techniques for orienting the gyro-magnet in an inverted position will be described in the second part of this series.)

When a radio frequency source and its oscillating magnetic field are applied to the inverted gyro-magnet, precession occurs as in the previous example. However, because the gyro-magnet starts from an unstable position, the external radio frequency field aids the damping mechanism in returning the system to equilibrium instead of opposing it. (Fig. D.)



(d)

Now the gyro-magnet has excess energy which is supplied to the radio frequency excitation thereby providing signal amplification, until it finally returns to the point of equilibrium. Its south pole is aligned to the static field's north pole.

Thus the key to achieving amplification in a Maser is the inversion of the gyro-magnet (electron) into the non-equilibrium state. To accomplish this, either power must be supplied continuously to the system to overcome the losses which are trying to return it to equilibrium or else the system must be periodically disturbed and then used only during the brief interval (usually a few milliseconds) before equilibrium can be re-established by the damping mechanism.

One of the reasons for operating the solid-state Maser at extremely low temperatures is to delay this return-to-equilibrium process.

The technique used for disturbing the system constitutes the essential difference between pulsed and CW Masers which will be described in a subsequent article.

Paramagnetic Amplifiers

The heart of a solid-state Maser is a crystal containing paramagnetic atoms —that is, atoms having a net electron spin which makes them behave like

Father of the Maser

Discovery of the Maser principle of amplification (Microwave Amplification by Stimulated Emission of Radiation) generally is credited to Dr. Charles H. Townes of Columbia University. Townes and associates first demonstrated the principle in 1954 using ammonia gas.

Discovery of the Maser, like that of the transistor, did not stem from a search for a new type of amplifier. Rather it resulted from the idea of using microwaves instead of visible light in spectroscopy to study the structure of gas molecules.

FLIGHT TEST ENGINEERS

. . . will be interested to know that the design and manufacturing facilities of Wallace O. Leonard, Inc., Pasadena, are now available to firms in the aircraft and missile field whose need is for flight test instruments of outstanding accuracy that must function reliably under extreme environmental conditions. The following force-balance pressure instruments are available with ten turn rotation of a single-turn and a ten turn output potentiometer to minimize telemetering and flight recording errors:

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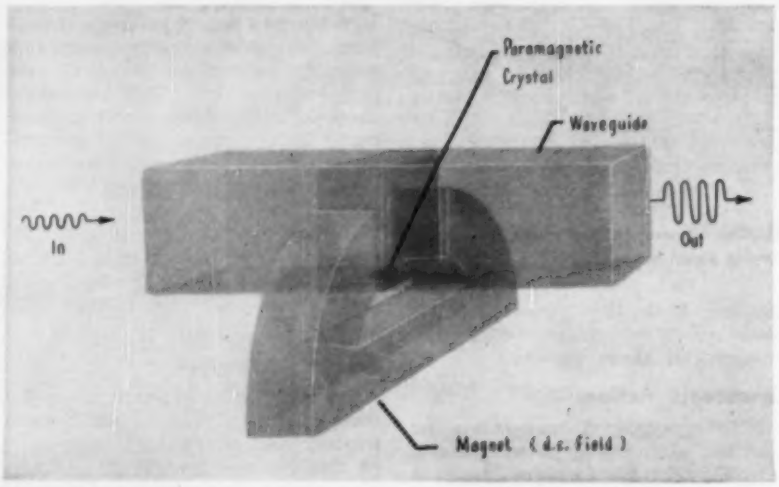


DIAGRAM of a simple paramagnetic amplifier (Maser) showing relationship of magnet, paramagnetic crystal and waveguide.

small gyro-magnets. Atoms with this property are found primarily in the transition groups of the periodic table and include such elements as iron, nickel, chromium, manganese and copper of the iron series, the cerium, praseodymium, neodymium and gadolinium of the rare earth series.

The amplification (gain) of the Maser depends upon the magnetic moment of the crystal which in turn is proportional to the number of atoms per unit volume which have electrons with spin available for resonance. This means the Maser crystal material must have a high concentration of paramagnetic atoms for efficient operation.

Crystal Temperature

The temperature of the crystal is important because it determines the percentage of the total paramagnetic atoms that will be available to contribute to the net magnetic moment. The lower the temperature, the higher the percentage available.

The crystal in which these atoms are incorporated must not distort them too severely so that once the spin axis has been inverted it will remain so oriented for a relatively long time with energy available for amplification.

Properties of many suitable materials have been measured and tabulated during the past 10 years.

Attainable concentrations of paramagnetic atoms, crystalline distortion of the atom and relaxation times are known and tabulated for a variety of materials.

Most straightforward way of using the solid-state Maser crystal is to place it in a waveguide which is propagating the signal to be amplified. An external magnetic field is then applied at right angles, its strength being selected to provide an electron spin resonant frequency (precession rate) equal to the applied signal frequency.

To obtain net amplification, energy received from the active Maser material must exceed dissipative losses in the waveguide walls. This means that sample magnetic energy per unit length must be large because the Maser gain per unit length is proportional to the energy stored in the inverted gyromagnets (magnetization).

Serious limitation of this simple construction arises because of the large sizes required for appreciable gain. For example, a paramagnetic Maser having a bandwidth of 10 mc. and a gain of 10 might require a waveguide measuring about three feet in length. One way to reduce this is to use a regenerative type amplifier employing a cavity so that the applied radio frequency signal bounces back and forth through the Maser crystal.

Other modifications of the microwave circuitry are possible to obtain desired Maser characteristics. The particular structure used depends upon the application because the gain-bandwidth relation is determined by both the material and the method used to apply the signal to the active spins.

Basic Requirement

Basic requirement for any of these systems is essentially the same as for a conventional amplifier: the paramagnetic material must supply enough energy to overcome circuit losses in the structure in order to achieve a net gain.

If there is some feedback, and the material emits enough power to exceed not only the internal losses but also those in the load attached to the device, then the system will oscillate.

In this respect, once the material parameters are know, the particular sample can be characterized by an

Jack Herlihy (c), Vice President of Engineering & Maintenance, and William C. "Red" Mentzer (r), General Manager of Engineering, discuss precision operation of UAL's San Francisco Maintenance & Engineering Base with Fisher (l).

Another in a series on the care taken by leading airlines to maintain top flight efficiency—and why this care has led them to select

CHAMPION SPARK PLUGS

Noted aviation authority reports on United Air Lines . . .

"Red Carpet" On The Mainline

By HERB FISHER
international aviation authority, veteran test pilot, author

United Air Lines' Red Carpet service means luxury all the way – the Mainliner way.

The flying Red Carpet fleet is aloft 1,700 hours a day, safely covering 380,000 miles every 24 hours.

Last year, United flew more than 6 million passengers along its 14,000 miles of routes serving 80 cities in the United States and Hawaii. More than 4 million people enjoyed Mainliner first-class service while almost 2 million rode United's comfortable coach flights, both the last word in safety and dependability.

To the aviation industry, safety and dependability are more than words. They're goals for achievement. And when I visited UAL's San Francisco Engineering and Maintenance Base, I saw the inside operation that makes safety and dependability a red-carpet fact for the No. 1 coast-to-coast airline.

"Here we do all the heavy maintenance," Jack Herlihy, Vice President, Engineering and Maintenance, told me, "and our first objective is to achieve the maximum humanly possible in safe aircraft for the traveling public."

Under the direction of a dynamic trio – Mr. Herlihy; W. C. "Red"

Mentzer, General Manager, Engineering; and W. P. Hoare, General Manager, Maintenance – engineering and maintenance personnel combine to guarantee top operating efficiency of United's 180 aircraft. All old friends of mine, these three men and their dedicated staff are a driving force there at the SFO Base.

HERB FISHER

I spent several days at this 128-acre maintenance base fronting on San Francisco's International Airport. There wasn't a section of the million square feet of floor space I failed to see – hangars, overhaul docks, shops, test cells, storage and stock areas, service and training headquarters, office buildings, even the aircraft run-up pads – all of it comprising a "push-button" maintenance base that's recognized as one of the most modern and complete in the nation.

From a small, split operation at Oakland Airport and Cheyenne, Wyoming, in 1941, United has mushroomed with atomic impact in the aviation industry. With today's maintenance operation centered at San Francisco, total UAL investment in buildings at year-end stood at $17,210,900, with 5,677 employees on a $31,789,662 payroll – just at San Francisco alone.

Current maintenance-hangar construction will boost United's San Francisco investment to $24,495,900 by June of 1958.

Each year, hundreds of skilled mechanics, technicians and craftsmen work with engineering specialists to overhaul 250 to 300 aircraft and more than 1,500 engines. Maintenance standards and procedures are rigid.

On a precise schedule of preventive maintenance, each UAL Mainliner and Cargoliner is routed to San Francisco for progressive overhaul. This is planning at its best. It is one of the most perfectly synchronized operations I've ever seen.

A Mainliner is assigned a hangar. Ten minutes after being squired into position, it is literally caged by catwalks, frameworks and platforms. Powerful jacks lift the plane. Overhead cranes move in to support engines while they're dismantled. Control surfaces, instrument panels, wheels and brakes, seats, buffets and all other removable components are "pipelined" to their respective shops. Metal workers, X-ray specialists and inspectors move into the stripped fuselage to probe for metal fatigue, corrosion and wear.

Meanwhile, the giant engines have gone into the Powerplant Section, where they're steam-cleaned, torn down, and part-by-part chemically washed and minutely examined, in strict conformance to United's rigid specifications.

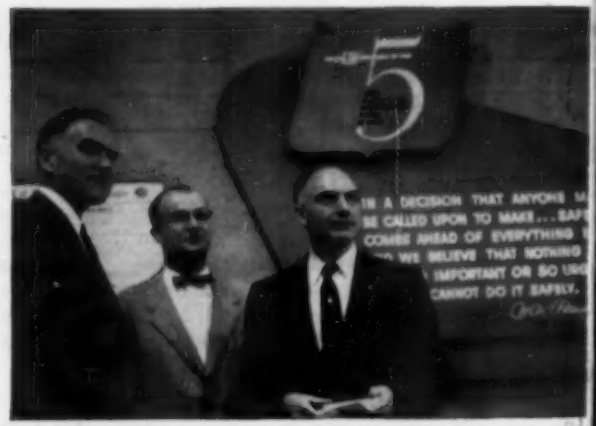
After engine reassembly, valves are adjusted, timing is set and test cells are readied. There, with the deft care of surgeons, specialists check each engine pulse to doubly assure perfection before mating the engine with three others to form the safe and dependable power package of a UAL Mainliner.

"Dependability is of such great importance," Red Mentzer told me, "that we cannot afford to use a

Fisher discusses extensive flight testing of reconditioned aircraft with (L/R) Robert M. McIver, Test Pilot; W. E. "Dusty" Rhoades, Flight Engineering Manager; and Robert C. Collins, Test Co-pilot.

"Usually, where statistical data blames spark plugs for ignition system troubles, we find the spark plug is the victim and not the cause," reports Bill Pitt, Line Service Engineering Manager.

"Rule of Five" sign points up safety, passenger comfort, schedule performance, honesty, sincerity. Pictured are (L/R) Fred Page, Maintenance Division Manager; H. R. Williams, Powerplant Manager; Hadley Queen, Maintenance Manager Assistant.



second-rate product any place in our operation.

"Take spark plugs," said the top man in Engineering and 24-year UAL veteran. "We've been using Champions as standard equipment on all of our airplanes for more than 10 years. We've tested many different types of spark plugs during that time. We've found, however, that Champion has developed its product more rapidly than anyone else. Result is – since we've used Champions we've enjoyed the best over-all ignition experience of our entire history."

As Jim Goodart, a maintenance expert in Line Service Engineering, put it: "We have yet to find one engine failure caused by a Champion Spark Plug. With these DC-7 engines costing about $120,000 each, the importance of product reliability is obvious. Sometimes a spark plug is blamed for trouble when actually it is not at fault. We've found that Champion is the best we could possibly use."

Harry Taylor, Superintendent of Powerplant Engineering, said: "We've always emphasized dependability, long life and economy. We feel that no other spark plug has thus far provided us with a full measure of these requirements."

Frank H. Griggs, buyer in United's Purchasing Department for 19 years, calls it business integrity and forward thinking on the part of Champion.

Just as a good airplane is the composite idea of designer, builder and user, so is development of a spark plug largely the result of cooperation between manufacturer and user.

One of United's technician engineers, Thomas Preitkis, told me this: "United has attended Champion Ignition Conferences every year for the past seven. There, airline operators get together with Champion engineers to discuss their problems. The result of such meetings is a spark plug that meets the needs of the airline operator, a spark plug offering greatly improved performance . . ."

Dependability the Champion way is 1,000 hours of service. New spark plugs are installed in UAL's Pratt & Whitney and Curtiss-Wright engines and, after 500 hours of operation, they're removed by line maintenance people and returned to the base for reconditioning. Then they're put in service for another 500 hours.

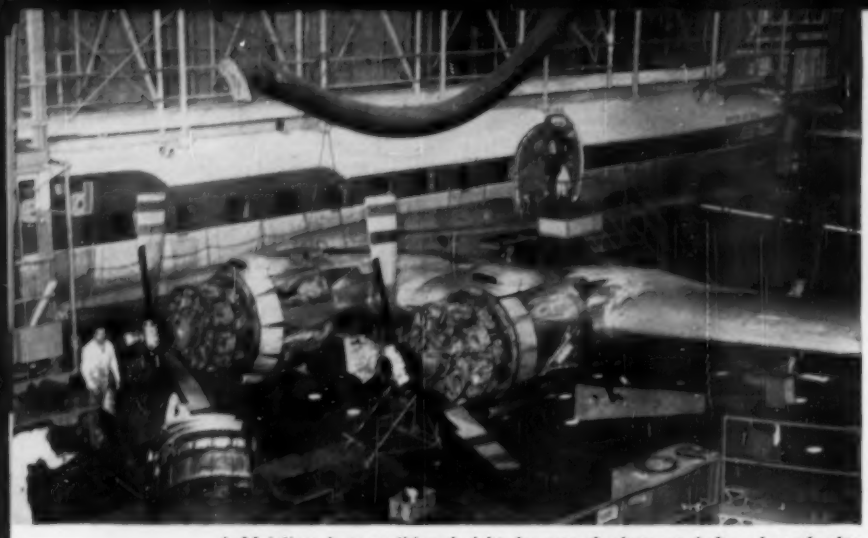
"In terms of operating costs," Bill Pitt, Manager of Line Service Engineering, told me, "Champion has been able to extend the time between spark plug replacements so that we are now realizing as high a time as any airline in the industry. This represents a saving in direct man-hours and in less frequent need for overhauling or service . . ." Mr. Pitt began his career with United 27 years ago as a cleaner and has progressed through all levels of mechanical maintenance. He speaks with authority, then, on economy and dependability.

"Actually, the spark plug is one of our finest tools for evaluating combustion chamber irregularities, such as burned pistons and valves," Mr. Pitt said. "By careful study of the electrode end of a spark plug removed from a malfunctioning engine, we've determined actual cause

Describing tests of all kinds of spark plugs and reasons for using Champions exclusively the past 10 years are (L/R) Harry Taylor, Powerplant Engineering Superintendent, and Frank H. Griggs, Purchasing Department Buyer.

Planning precise scheduling for aircraft overhaul are (L/R) W. P. Hoare, General Manager of Maintenance, and G. E. Keck, Assistant to V.P. of Engineering and Maintenance.

Earl Koehler (L), Champion Representative, gives technical assistance to Tom Preitkis (C), Powerplant Engineering Assistant, and A. G. "Hap" Gronenthal (R) of Spark Plug Maintenance.



A Mainliner is reconditioned right down to the last nut, bolt and spark plug.

of the trouble and avoided some rather destructive engine failures."

General Manager of Maintenance – Mr. Hoare – emphasized UAL's success with Champions: "United's experience has demonstrated Champion's consistently dependable performance under widely varying operating conditions," said the 30-year UAL veteran.

Those who occupy the "front office" of the airplane itself, those who bear the final responsibility for safe operation of the aircraft in flight, have the deep personal appreciation of the meaning of reliability. United's Flight Test Section employs 15 experienced pilots and flight engineers. During a hangar flying session with these test pilots, I learned just what Champion does mean to them.

Robert M. McIver, a Test Captain for UAL, said: "My experience dates back to 1933 and includes some 10,000 hours' flying time, 6,000 of it flight testing. We have a tremendous sense of moral responsibility toward each airplane we release, since we realize each plane will cover millions of miles under all kinds of conditions before returning again for overhaul.

"Part of our job, then, is to devise exhaustive tests for each component of the plane, and these tests we carry out religiously. The work of Flight Test is the end point in a long line of maintenance and inspection procedures, and we have authority to fly each plane as much as necessary to insure the ultimate in quality. Each component must fall within very tight tolerances before it can be considered satisfactory. Naturally, the engines and their accessories are subject to very close scrutiny . . . and spark plugs fall into this category.

"During each flight test, our flight engineers observe spark plug performance continually by means of ignition analyzers, and pilots do likewise indirectly by means of the instruments on the power panels.

"Using this instrumentation, we've been watching the performance of Champion Spark Plugs for 10 years. The excellent characteristics of these spark plugs have become not just a matter of personal opinion, but a matter of statistical record. We can summarize that record by saying that Champions meet the tough requirements of an airline operation and are backed by a good service organization . . . "

Captain McIver's comments were seconded by UAL Test Pilot Robert C. Collins, who told me that so far as he knew no other spark plug has ever come close to replacing Champions at United.

UAL's record of safety and dependability reflects the reliability of the heart of its aircraft ignition system, the Champion Spark Plug.

Red Carpet means *the finest*. To millions of passengers it means the ultimate in reliability, service and comfort. In a Mainliner, it means the ultimate in engineering and maintenance.

When you fly United, you're flying *Red Carpet*.

by HERBERT O. FISHER

Cabin view of Curtiss-Wright simulator, which electronically duplicates flying characteristics of DC-6B Mainliner, shows United crew solving flight problems "inserted" by instructors. UAL has seven of these – largest number owned by an airline – for advanced pilot training.

Harold McCray calibrates with fluxgate compass transmitter.

Unique with United is this special briefing room with a 14,000-mile view. Specialists brief company executives in Denver every morning on system-wide airline operations for past 24 hours – plus a forecast of the next 24. This contributes to constantly improved service.

CHAMPION SPARK PLUG COMPANY • TOLEDO 1, OHIO

effective "Q" (negative for a system that emits power) which can be coupled to the waveguide system and calculations can then be carried out as for any other cavity attached to a waveguide.

Similarly, for the straight waveguide case the material is described in terms of a negative attenuation constant and the net power change can then be calculated in a straight-forward manner.

For the straight guide device, for example, the net gain is given by the following equation:

$$\text{Gain} = e^{(\alpha - \alpha_g)\,d}$$

Where:

α_g = Waveguide attenuation constant.
d = Waveguide length
α = Stimulated emission gain coefficient

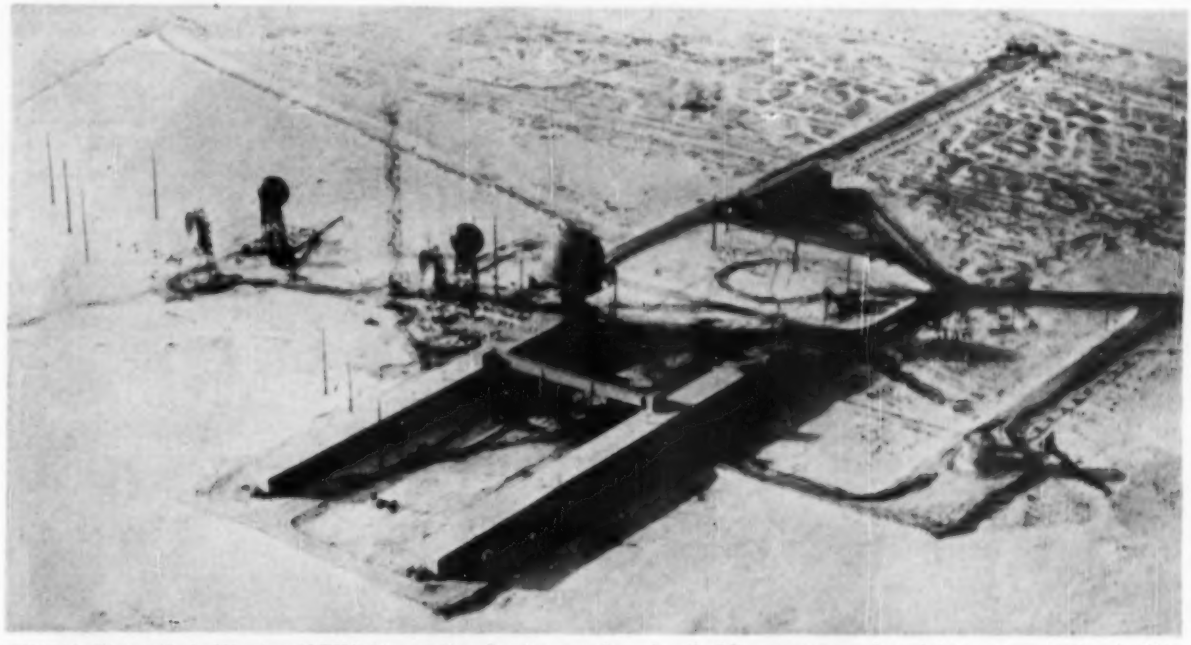
For a paramagnetic sample: the stimulated emission gain (a) is established from the following:

$$\alpha = \frac{2 \times 10^{-23} N_0 f^2}{B\,T}$$

Where:

N_0 = Total density of paramagnetic atoms.
f = Operating frequency.
B = Bandwidth
T = Absolute temperature of crystal

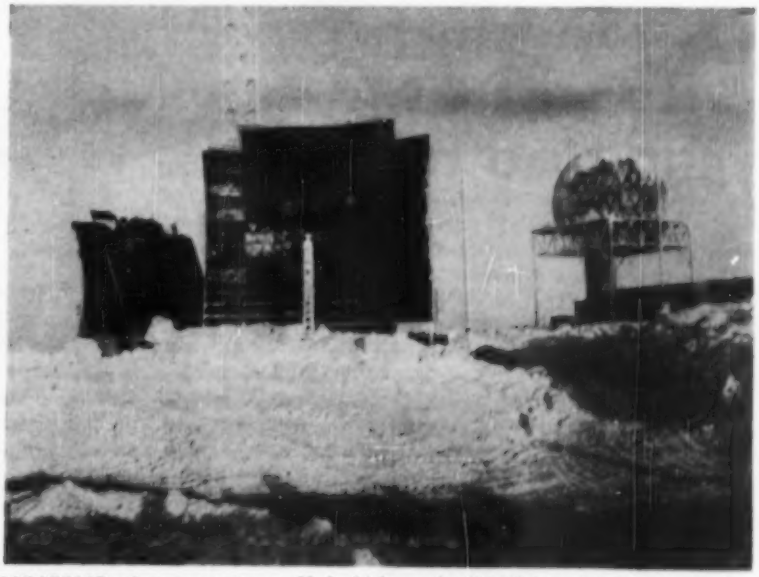
Representative values for a device



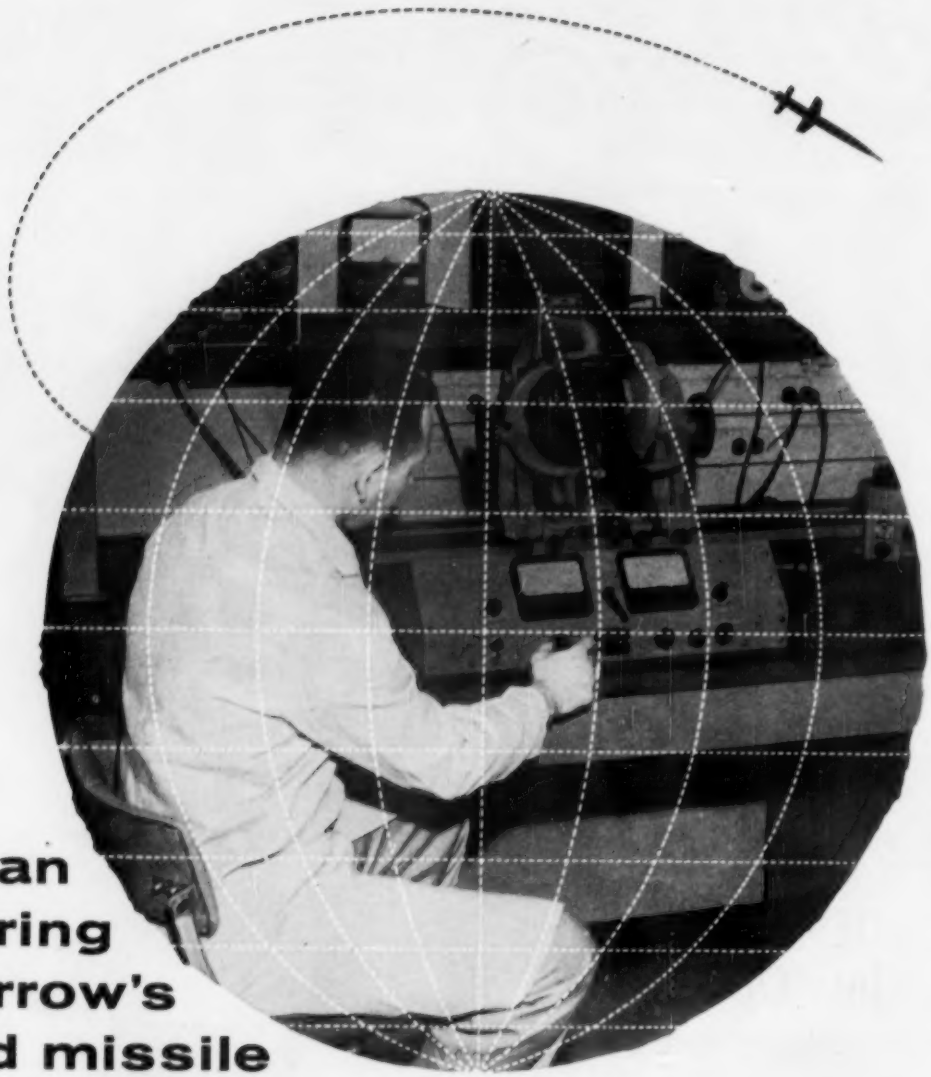
TYPICAL Distant Early Warning (DEW) Line station showing complex of outbuildings, access roads and intercommunication facilities surrounding the dome shaped housing of the main search antenna. DEW line officially became operational this summer.

DEW Line Goes Into Operation

DIRECT and overwater strike route chart showing interrelation of ground-based and coastal airborne early warning systems as described in a talk by Brig. Gen. K. H. Gibson.



PARABOLIC microwave antennas 60 ft. high are for DEW Line intercommunication system. Due to concave surfaces, antennas must be heavily stressed against prevailing high arctic winds. Sites were installed for USAF by Western Electric Co., will be operated by International Telephone and Telegraph.



This man is steering tomorrow's guided missile

His uniform is a laboratory coat, his cockpit a dust-free room with carefully controlled temperature and humidity. He's a skilled General Mills gyro technician—as much a part of the defense of his country as the jet pilot. Results from his work, and from work in other R & D labs, assure us that tomorrow's guided missiles will be even more accurate than today's. ¶ At the Mechanical Division of General Mills, the gyro lab is part of a talented, well equipped guidance and navigation systems development group. The group also includes top men and facilities in infrared, microwaves, electronic and mechanical design, and overall systems engineering. We team these men and facilities with a complete precision production plant to handle systems, sub-systems and major assembly problems for the world's most exacting customers. Possibly you too can benefit from our capabilities.

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MECHANICAL DIVISION

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operating at a frequency of 10,000 mc., with a bandwidth of 10 mc., using a paramagnetic crystal containing 10^{18} atoms/ cm.^{3} (N_o), operating at an absolute temperature of 4K (—269C), works out to give a stimulated emission gain coefficient (a) equal to 0.05/cm. With negligible waveguide losses (a_e= O), this would provide an overall gain of 10 in a waveguide one meter long.

The properties of several different types of Masers, including the new ferromagnetic amplifier, and the operating techniques peculiar to each, will be described in the second article of this series.

FILTER CENTER

▶ **Unreliability in Reverse**—MATS Pacific Division is studying recommendation that failure of Loran be considered cause for grounding aircraft on long overwater routes. Old fashioned celestial navigation is thought to be too unreliable; opinion is growing that it should be regarded only as a backstop for electronic navigation aids. Tests on operational flights checking celestial navigation against Loran found:

• **Celestial navigation** is less accurate than is desirable.

• **High cloud cover** interferes with celestial sights too frequently.

• **Complete fix is** possible only at night with celestial navigation. During daylight only a single line of position from the sun can be obtained.

• **If autopilot** or instruments to which it is slaved fail, a celestial fix is impossible because manually piloted aircraft does not provide needed stable platform.

▶ **New Doppler System**—Doppler navigator, specifically designed to meet commercial airline requirements, will be developed by Bendix Aviation, according to announcement at a recent meeting of the AEEC Self-Contained Navigational Aids Subcommittee in Los Angeles. Prototype deliveries will coincide with delivery program for the Douglas DC-8 and Boeing 707 jets. System will be frequency modulated and continous wave operating on X-band and will feature packaging of all electronic circuitry in plug-in ATR cases.

▶ **Transistor Market Growth**—Possible billion dollar market for transistors and other semiconductors within ten years has been predicted by a General Electric executive. Sales of these devices have continually outstripped even the most optimistic market projections, according to J. H. Sweeney, manager of marketing for GE's Semiconductor Products Dept., who said that this years sales volume for the industry is expected to exceed $140,000,000, which is 40% over the predicted figure and 82% over the industry sales for 1956.

▶ **Vanguard computer**—Automatic Recording and Reduction Facility (ARRF) to process flight information from each of the three stages of the test and satellite launching vehicles will be installed by early fall at Air Missile Test Center near Coca Beach, Fla. Facility, which operates on the same principles as a high speed digital computer to produce vehicle performance data within 72 hours, is a joint development of the U.S. Naval Research Laboratory and Radiation, Inc.

▶ **"Please Remain Calm"**—Airborne tape recorders, which some airlines plan to install in jetliners to provide background music, may also be used to give prerecorded warning announcements in event of unintentional decompression at high altitude. Warning message would be delivered automatically when decompression actuated pressure switch.

▶ **No Change of Heart**—Hourly employees at Kearfott Company's Asheville, N. C., plant have rejected union for fifth time since 1952, with vote of 223 to 77 against representation by

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AMERICAN ELECTRONICS, INC.

4 to 250 cfm

MOTOR BLOWERS

Model 700 one cubic inch blower delivers up to 4 CFM
Model 220 Double Ended Blower. Designed and built by American Electronics to beat the heat problem where plenty of air is needed.

Engineers . . . Exciting job opportunities in Southern California

American Electronics' engineers design motor blowers to meet problems, not just move air. And these engineers draw on the experience gained in years of producing motor blowers of every possible type and function. As a result, every design requirement is precisely translated to produce a light, compact unit that will do the job it was designed to do with maximum efficiency.

Ranging from 4 CFM to 250 CFM, American Electronics manufactures a complete line of DC and AC centrifugal blower and fan motor units for a wide variety of functions and applications. AC motor units are available in single or 3 phase at 115 v, 400 cycles. DC units from 12 to 230 volts. All meet pertinent Military Specifications.

Blowers for high back pressure applications or any other special requirements, custom designed and manufactured to specifications.

Write or wire Dept. 230A for specifications and complete information.

AMERICAN ELECTRONICS, INC.

Electro-Mechanical Division
655 W. Washington Blvd.
Los Angeles 15, California

Other products manufactured by American Electronics include: AC and DC Miniature Motors; Gearmotors; Clutches; Brakes; Motor Alternators and Power Supplies; Electrical Ground Support Units; Air Conditioners; Resolvers; Servo Motors; Nuclear Instrumentations and High Fidelity Tape Recording Systems.

International Brotherhood of Electrical Workers.

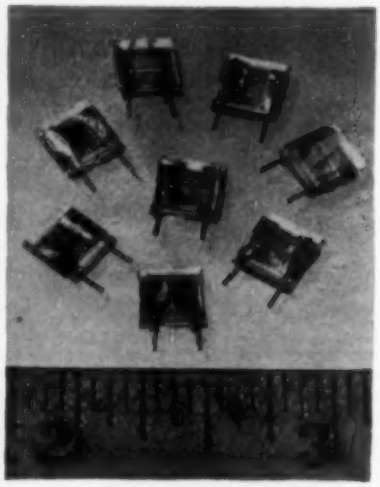
► **LFE Builds Taxi Radars**—Navy has accepted first of 10 AN/GPN-6 airport surveillance radar systems being built by Laboratory For Electronics. Remainder are scheduled for delivery within six months.

► **Stavid Wins**—Stavid Engineering, Inc., Plainfield, N. J., has beaten out 11 competitors to receive Navy contract to develop airborne radar for use in the AN/ASB-8 bomb director system for attack-bomber aircraft.

NEW AVIONIC PRODUCTS

Components & Devices

• **Subminiature fixed glass capacitors,** Type WL, feature radial high temperature soldered leads for direct connection to printed circuit boards. WL-4 measures 0.3 by 0.3 in. and is available in values to 1,000 mmf. WL-5 is 0.3



by 0.5 and is available to 2,200 mmf. Both types are less than 0.1 in. thick. WL's are rated at 300 volts to 85C. Corning Glass Works, Corning, N. Y.

• **Size 10 synchros** capable of operating for 100 hours at 450F and for 1,000 hours at 350F have been developed for direct turbojet engine mounting. Units are available as transmitters, transformers, differentials, and resolvers. With rotor as primary, transmitter characteristics are 26 volt, 0.145 amp. input, 11.8 volt output, 206 mv/deg. sensitivity, and 8 deg. phase shift. Developed by Clifton Precision Products Co., Inc., 9014 West Chester Pike, Upper Darby, Penn.

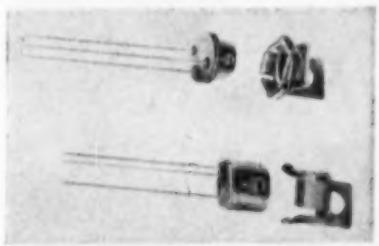
• **Electronic commutator** for airborne telemetry applications, Series ETC-30,

is claimed by the manufacturer to be the first commercially available unit of its kind. Commutator is offered with any sampling rate from 75 to 900 points per second, and meets all IRIG requirements for PAM and PDM commutated telemeter and magnetic tape systems under MIL E-5727A environment. Errors due to drift, crosstalk, and nonlinearity are less than 0.50%. Power required is 150 volts DC at 12 ma.

Size is 3 in. in diameter by 5 in. long. Weight is less than 2 lb. Unit developed by Arnoux Corp., 11924 West Washington Blvd., Los Angeles 66, Calif.

• **Heat sinks,** Models HS-10 and HS-20, permit higher levels of dissipation for tansistors and provide a mounting clamp for tansistors suspended by their leads.

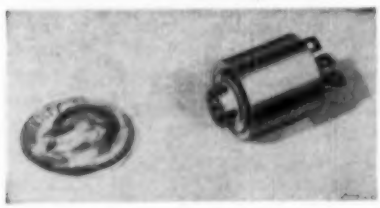
Model HS-10 is designed for the



GT soldered case and HS-20 for the GT version of the JETEC 30 case. Both models are made of beryllium copper. Manufacturer is General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y.

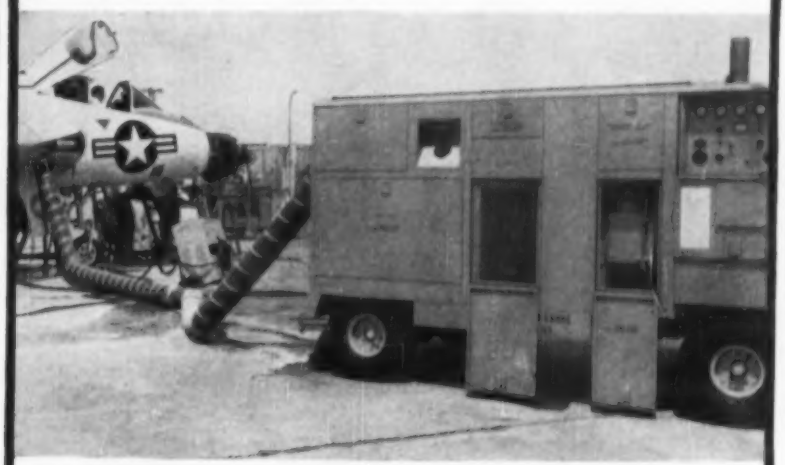
• **Transistorized electrohydraulic valve** amplifier has 30 db. power gain and will operate at temperatures to 170F. Capable of operating with 60 cycle or 400 cycle excitation, the unit includes variable gain, balance, and quiescent controls in a package measuring 1 in. by 2 in. by 3 in. Manufacturer is Control Specialist Division of Kelsey Hayes Co., Detroit, Mich.

• **Subminiature potentiometer** called Mite-E-Mite weighs 10 grams and is capable of operating to 125 C. Unit measures 0.5 in. in diameter by 0.5



in. long and can be solder-mounted. Unit is produced by General Scientific Division of San Fernando Electric Mfg. Co., San Fernando, Calif.

there's a heat barrier on the ground, too!



With so much talk about the various in-flight "barriers," it should be mentioned, there is a "heat barrier" problem for jet aircraft on the ground, too. Ground checking of instrumentation and other parameters requires efficient and dependable cooling. That's why manufacturers like Douglas Aircraft Co. use American Electronics' MA-3 ground support air conditioners on the F4D-1 SKYRAY and other aircraft.

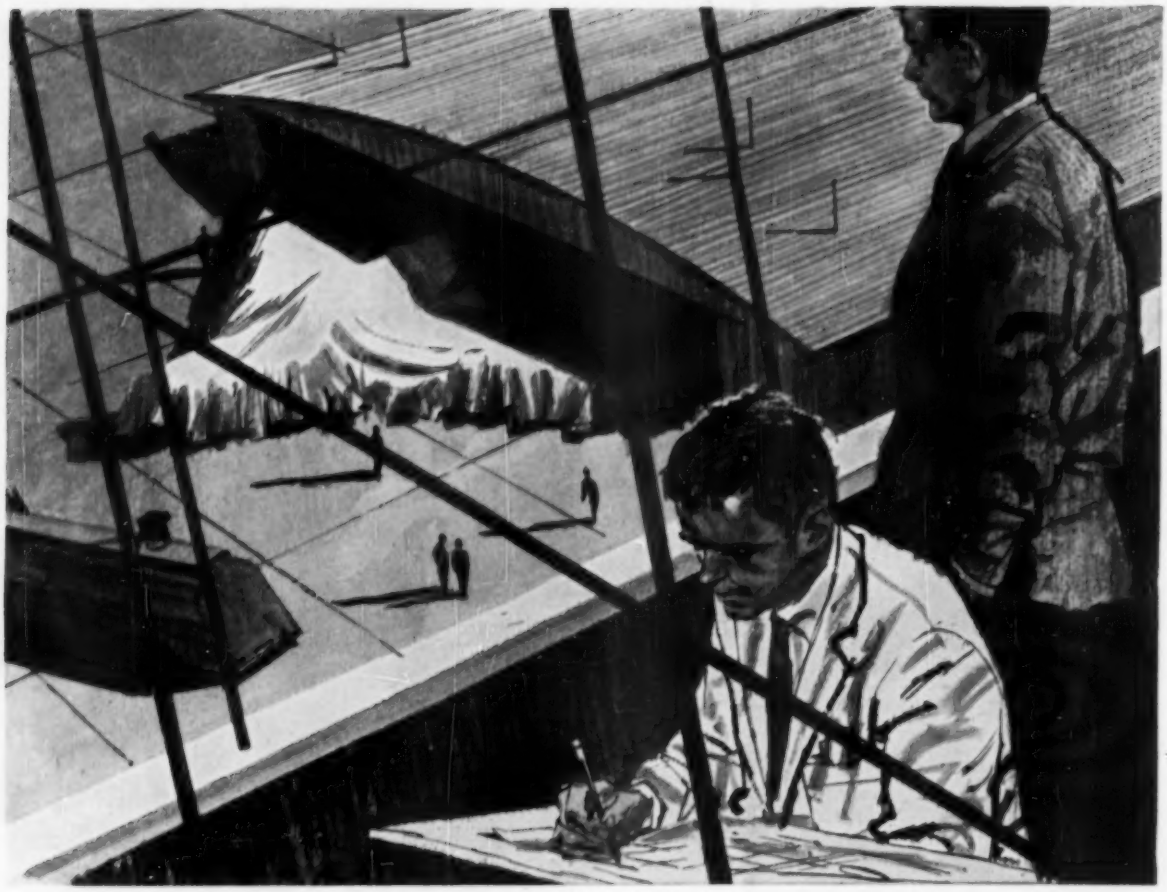
The unit shown here has a "design load" output rating of 100 lbs/min of 45F air against 0 to 3 psig static pressure with controllable output temperatures ranging between 35F and 65F. The unit is designed to perform under all world wide operational conditions including ambient temperatures ranging from —65F to 137F. American's MA-3 is gasoline engine powered, but is also available with electric motor drives and is but one of a series of designs and capacities available. Construction and instrumentation are such that satisfactory operation and maintenance may be obtained with relatively untrained personnel.

If you have aircraft ground support cooling or heating problems, why not consult with American Electronics Engineers? They can provide an economical solution.

AMERICAN ELECTRONICS, INC.

Marketing Division
655 W. Washington Boulevard
Los Angeles 15, California

Other products manufactured by the Electric Machinery & Equipment Division of American Electronics include: Motor Alternators, Static Power Supplies, and Magnetic Amplifiers.



Avro Aircraft Limited has achieved a brilliant record, creating the famed Jetliner, the rocket-firing CF-100 and soon now, the supersonic Avro Arrow. Still shrouded in secrecy, advanced aeronautical projects now in the design stage, present new challenges to men with imagination and vision who have a sound background in engineering, mathematics, physics, aerodynamics, metallurgy or computer programming.

startling things are happening in CANADA at AVRO

Enthusiasm and excitement keynote all aspects of design and engineering at Avro. For Avro Aircraft's advanced projects are pushing into the thermal thicket . . . rising into the stratosphere. There new mysteries remain to be solved; new challenges loom for men with skill and ingenuity.

Association with these projects stimulates the creative imagination of the engineer, the mathematician, the metallurgist and aerodynamicist. Every problem becomes a new, interesting and inspiring experience.

You will work in Malton, Ontario, a suburb of Metropolitan Toronto. You will be assigned to an advanced engineering team. You will be assisted by the most advanced electronic computing equipment in the world. You will receive company-paid group life, sickness and accident insurance and you will be eligible to participate in a retirement income plan. Your progress will continue as rapidly as you demonstrate your ability.

For complete information, write us today. We will forward application forms and gladly answer any questions you may have.

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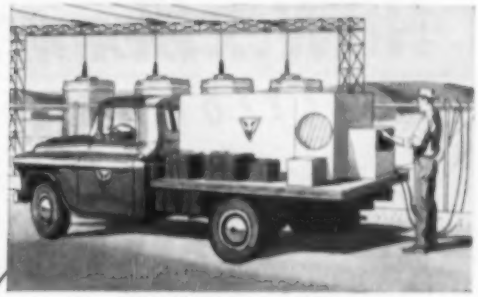
MEMBER: A. V. ROE CANADA LIMITED AND THE HAWKER SIDDELEY GROUP

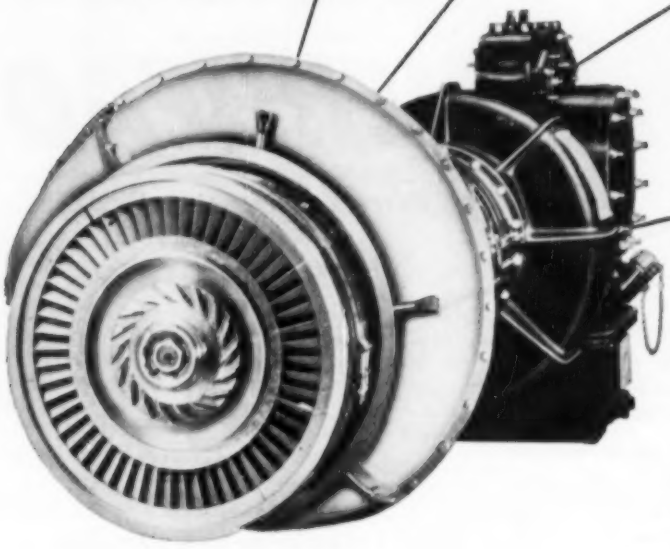
Ground support for jet aircraft.

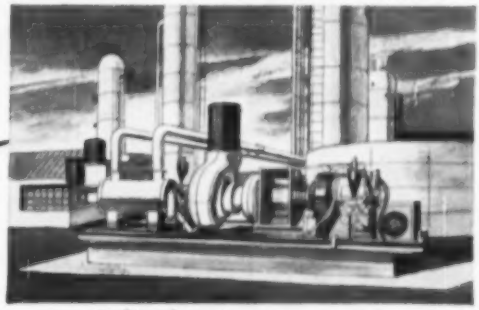


Portable power generation.

Jupiter® finds new uses!

Power for small boat propulsion.





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JUPITER GAS TURBINES provide reliable power for a wide range of military and industrial uses. Simple and rugged, compact and lightweight, the 500 hp Jupiter offers many advantages over conventional power plants. New users praise its high power-to-weight ratio, its instant starting even under severe temperature extremes, its easy portability and low maintenance requirements. Experience has proven the effectiveness of Jupiter gas turbines for power generation, boat propulsion, mechanical drive and still other applications. Perhaps this versatile engine can help solve your special power problems. Write for new Solar gas turbine brochure... Dept. D-66, Solar Aircraft Company, San Diego 12, California.

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BURBANK, CALIFORNIA

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WEATHERHEAD

First in Fluid Connections

Weatherhead is pleased to announce the appointment of Pacific Airmotive Corporation, Burbank, California, and Airwork Corporation, Millville, New Jersey, as distributors for its aviation products . . . hydraulic and fluid system components.

With these new appointments, Weatherhead products are now available to aircraft owners and operators across the nation through factory-trained personnel of the two companies. And in the Southwest, Weatherhead products will continue to be available through Associated Aircraft Supply Co., Dallas, Texas.

These distributors provide prompt, reliable delivery at lowest possible cost, to airlines and suppliers. Through their networks of authorized local dealers, who also maintain adequate stocks of Weatherhead products, these distributors offer fast service to aircraft owners and airport service operators.

AIRWORK CORPORATION
MILLVILLE, NEW JERSEY

Distribution and sales in a 17-state area on the eastern seaboard, through its spare parts division . . . branches at Newark, N. J.; Washington, D. C.; and Miami, Florida.

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Aviation Division

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In Canada: 127 INKERMAN ST., ST. THOMAS, ONTARIO

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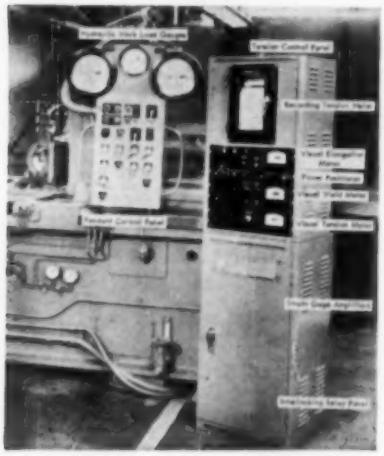
NEW AVIATION PRODUCTS



Device Controls Metal Fatigue

Designed to lessen problem of metal fatigue in vital missile and aircraft components, yield tension monitor will electronically control and test material for uniform strength while it is being formed on a radial draw former. Unit will virtually eliminate overstretching or breakage in materials such as titanium, stainless steel, magnesium, aluminum and tempermental alloys.

Unit was furnished recently to Army Ballistic Missile Agency, Huntsville, Ala., and will be used by Convair for work on the 880 jet transport.

Unit is made up of standard items, to permit servicing by local electronic representatives and is adaptable to full automatic operation.

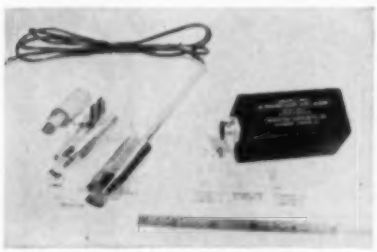
Cyril Bath Co., Solon, Ohio.

Liquid Level Point Sensor

Six-ounce liquid level point sensor for aircraft and missile fuel and oxidizer systems and propellant control, has no moving parts and operates over ambient temperatures of −200C to +125C. Basic sensor consists of hermetically sealed ultrasonic probe measuring about two inches long and $\frac{1}{4}$-in. outside diameter.

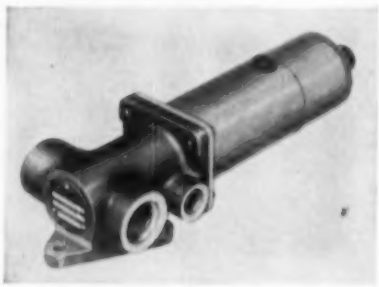
Response time of the sensor is less than 10 milliseconds. It will ignore foam or clinging doplets, can detect presence or absence of fuel flow in pipes down to one-inch diameter. Control units uses a single silicon transistor and no power is supplied to the probe when it is immersed in fuel.

Acoustica Associates, Glenwood Landing, N. Y.



Fuel Transfer Pump

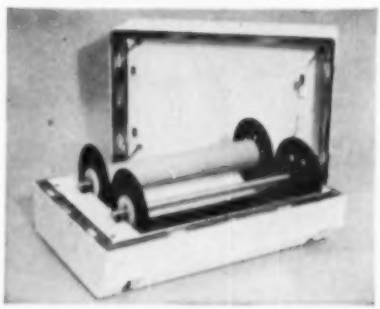
Model RG16140 reversible fuel transfer unit, weighing 1.6 lb., consists of a positive displacement rotary vane pump, an explosion-proof motor and radio noise filter. Sea level rating is 60 gph. with 5 psi. gage discharge pressure. Rating is based on pumping MIL-F-5572 fuel at 60F-100F; rates at 50



gph. with same gage discharge pressure at 15,000 ft.

Continuous duty motor operates at 27 v. d.c.; internal wiring to the electrical connector provides for reversing the direction of rotation through external switch connections.

Lear-Romec Division, Lear, Inc., Elyria, Ohio.

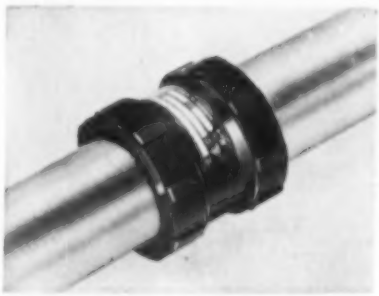


Tough Magazine

Crash-resistant record magazine for recording oscillographs is designed to take 400-G shock and 2,000F flame; in addition it is explosion-proof in accordance with MIL-E-5400A (ASG).

Magazine is eight inches wide x 12$\frac{1}{2}$ in. high x 17 in. long; with full load of paper it weighs 80 lb.

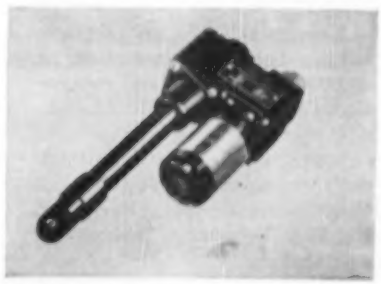
Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.



Missile Coupling

Flexible coupling designed for missile and aircraft applications meets MIL-C-25014 and allows a total of one-quarter-inch axial motion and ±30 flexure. Standard AND10058 and AND-10060 beaded tube ends are used for fitting attachment. Standard O-rings are used for seals; standard gland dimensions allow space for seal swell and easier motion of tubes. Part number is 6-6001.

On Mark Couplings, On Mark Engineering Co., 200 N. Ave. 64, Los Angeles 43, Calif.



Modular Actuators

Line of modular component aircraft linear actuators can be assembled from 64 standard interchangeable parts to meet a wide range of requirements. New line is stated to meet MIL-A-8064A.

Components consist of motor, gear reducers, limit switches (including filter or capacitor), accessory drive or transmitter and screw jack. Three broad operating classifications comprise the actuator grouping: L12, up to 350 lb.; L16, up to 1,500 lb. and L20, up to 3,500 lb.

Airborne Accessories Corp., Hillside 5, N. J.

Giant Template Camera

Camera being built to Convair specifications weighs over 10,000 lb., measures 30 ft. long and 8.75 ft. high, enabling reproduction of templates up to 5 ft. x 12 ft. within 1/2,000-in. ac-

Keeping a fatal rendezvous in 4-D

Any hunter who's fired at a fast-flying duck knows you have to figure *time*—the 4th dimension—if you want the shot to meet the duck in flight . . .

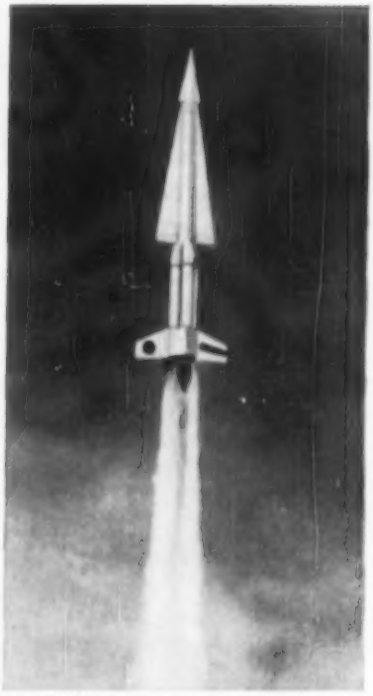
Now substitute an airplane taking full evasive action at 40,000 feet or more, and conventional ways of aiming become obsolete. Yet this problem is *relatively* simple, as was dramatically proved at the first tests of the Nike missile, jointly developed by Bell Telephone laboratories and Douglas.

Even more complex than ground-to-air marksmanship is air-to-air gunnery, where opposing planes top 1000 mph, and fire missiles that move twice that fast. It's an entirely new science, based on principles first expounded by a Douglas scientist, and proved in repeated successful tests—even against unseen targets.

Depend on
DOUGLAS
first in Aviation

Dramatic moment in aviation history, a Douglas-built Nike-Ajax bores in on a drone bomber.

A split second later finds the bomber in flames, as Nike-Ajax scores a direct hit.



Here is Nike-Hercules, soon to take over defense of U. S. cities from the earlier Nike-Ajax. Tripling the range of its predecessor, Nike-Hercules can be armed with a nuclear warhead, to knock out entire fleets with a single blast.

Douglas engineers load the rocket pod of an F4D Skyray. Fire control problems at supersonic speed, naturally much greater than encountered at stable ground emplacements, are solved on principles developed by a Douglas engineer. Consistent hits can be scored by planes approaching one another at close to a mile per second, and even when unseen.

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"On-location" generators, built and operated by Air Products, Incorporated, assure you a completely dependable supply of oxygen—liquid or gaseous—nitrogen or other gases . . . regardless of the quantity or purity you need. No problems of delivery holdups. High purity LOX and other gases are produced right in your own plant . . . on hand 24 hours a day, for uninterrupted operations.

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Many others are taking advantage of the Air Products approach . . . "on-location" generating facilities designed to take care of LOX, nitrogen or gas pressurizing needs. Detailed information is available upon request. Your inquiry is invited. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

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curacy. If the operator needs to reset the equipment after changing original setting, a vernier allows readjustment to within 1/1,000-in.

Equipment uses 42-in. film or plates can be focused manually or electrically.

Robertson Photo-mechanix, Inc., Chicago, Ill.

WHAT'S NEW

Reports Available:

The following reports were sponsored by Office of Technical Services, United States Department of Commerce:

Studies in Respiratory Physiology. Third Series: Chemistry, Mechanics and Circulation of the Lung.–by H. Rahn, The University of Rochester School of Medicine and Dentistry for Wright Air Development Center.–$2.25; 86pp. (P.B. 121803).

A Study of Permanent Magnets of the Barium Ferrite Type–by K. J. Sixtus, The Indiana Steel Products Co., for the Wright Air Development Center. $1.50; 53pp. (P.B. 121865).

The Effects of Interstitial Contaminants on the Noch-Tensile Properties of Titanium and Titanium Alloys. Part 2: Alloy Titanium.–by E. P. Klier and N. J. Feola, Syracuse University for the Wright Air Development Center. $5.50; 202pp. (P.B. 121575).

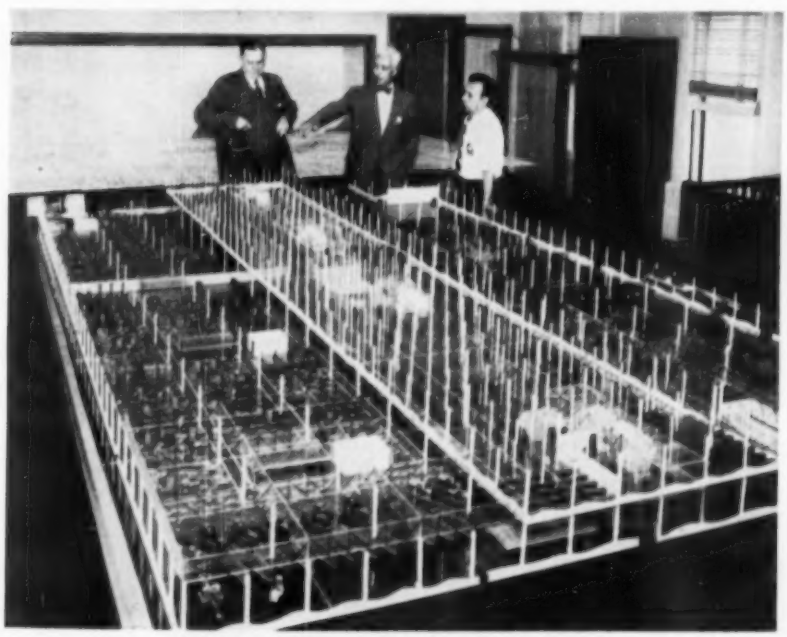
Surface Hardening of Titanium with Metalloid Elements.–by Armour Research Foundation for Watertown Arsenal, U. S. Army. $4.00; 151pp. (P.B. 111821).

Heat of Formation and Entropy of Titanium Tetrachloride.–by W. F. Krieve and others, California Institute of Technology for Ordnance Corps., U. S. Army. $.50; 17 pp. (P.B. 121734).

Transistor Feedback Amplifier Design–by G. L. Bennings, University of California for the Office of Naval Research. $.75; 29pp. (P.B. 121556).

Lovotron: A Low voltage Triggered Gap Switch–by E. H. Cullington, W. G. Chace, and R. L. Morgan, Air Force Cambridge Research Center. $.50; 19pp. (P.B. 121061).

Effects of Moisture Sorption on Weight and Dimensional Stability of Alkyd-Isocyanate Foam Core.–by V. C. Setterholm and E. W. Kuenzi, Forest



Model Shows Plant Layout

Three demensional model depicts new jet engine fuel control plant which will be placed in full production during October by Hamilton Standard Division of United Aircraft Corporation. The facility located at Windsor Locks, Conn., adjacent to the main plant will employ between 2,500 and 3,000 persons and have 410,000 sq. ft. of floor space. Structure will house a self-contained unit which includes fuel control engineering, experimental shops and production. Installation of machinery and equipment was to begin this month during the annual Hamilton Standard vacation shut-down. Model will be used by plant engineering to facilitate changes location of machinery and general plant layout.

"SHIMNUT" Spacer Plate Nuts

SAVES Time, Material Weight . . .

Eliminates use of NAS 463 shims. Permits use of single length screws at tapered joints. Available for bolt sizes from 10-32 to ⅜-24, spacer heights from 1/16 to 7/16.

Nuts are cadmium plated steel with nylon insert (ESNA 52Y) or all metal (SPS-F1309). Spacer is 7075-T6 Aluminum Alloy. Holder is Anodized in various colors to indicate height of spacer.

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90 or 560 CHANNEL RECEIVER

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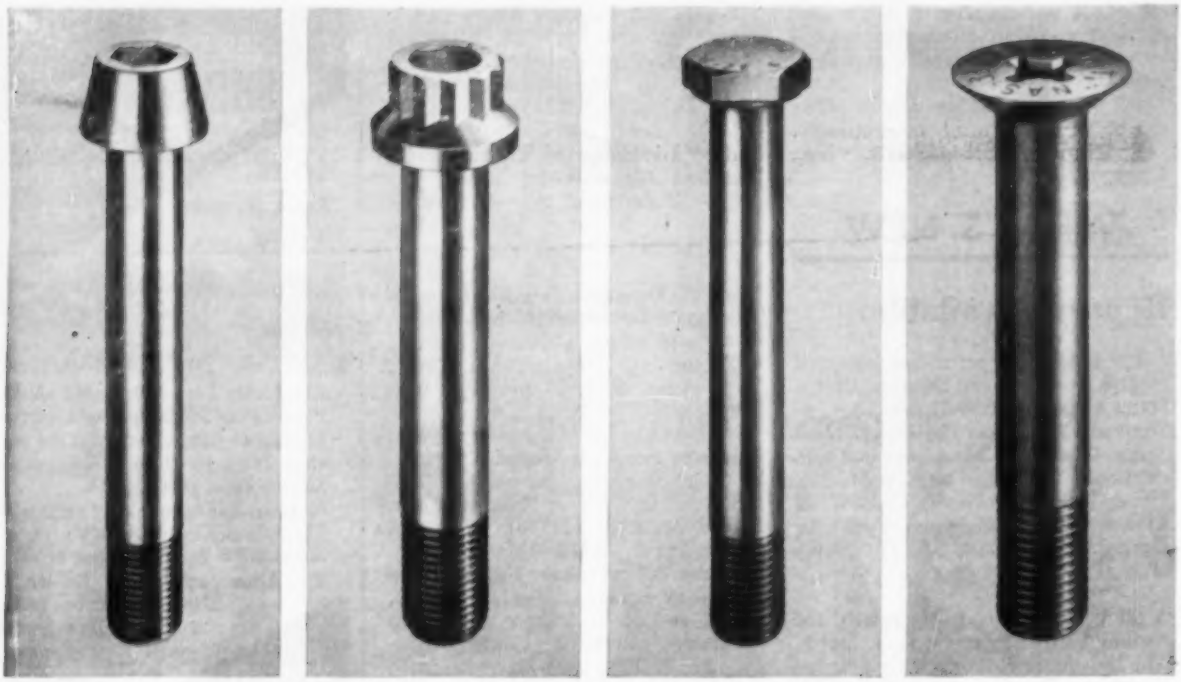
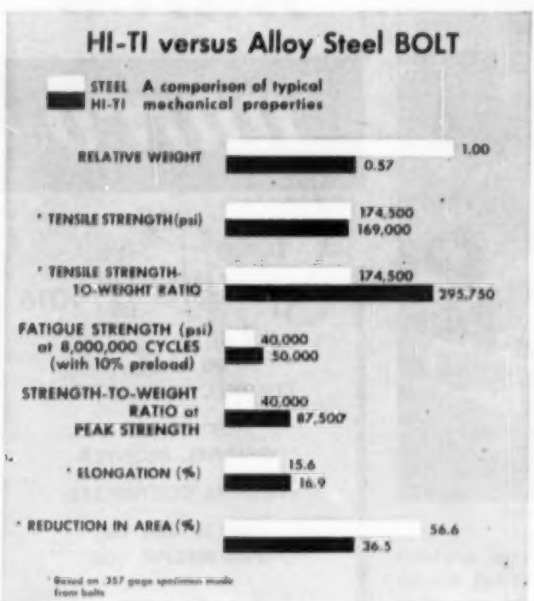


SPS Hi-Ti titanium aircraft bolts are regularly manufactured in four standard configurations: internal wrenching tension bolts, 12-point external wrenching tension bolts, hexagon head external wrenching shear bolts, and flush head internal wrenching shear bolts. Weighing 43% less than steel bolts of equivalent dimensions, they can save you as much as 1000 lb. per airframe—with no loss in strength.

SPS Hi-Ti titanium bolts help you build lighter airframes without sacrificing strength



Hi-Ti vs. alloy steel. Tensile, elongation and reduction area properties are based on the performance of bolt gage specimens. Endurance limit was determined by subjecting bolts to tension load alternating between maximum and 10% preload for a total of 8,000,000 cycles without inducing failure. Significant comparison is the strength-to-weight ratio at endurance limit.

SPS Hi-Ti titanium bolts help you solve the problem of reducing airframe weight without compromising strength. They weigh 43% less than alloy steel bolts of the same size. One lb. of them can do the work of 1¾ lb. of steel bolts. Yet in tensile-strength-to-weight ratio and fatigue resistance, they outperform steel.

Once considered a laboratory curiosity, titanium bolts have for some time been standard production items at SPS. Hi-Ti bolts are found in many advanced design operational aircraft. This is because SPS—producer of the first successful titanium aircraft bolt—invested over $500,000 and several years of high priority research in learning how to deal with this promising but sensitive metal. Today SPS has the most extensive facilities in the industry for the production and testing of titanium fasteners. As a result, we can give you both the technical assistance and the delivery you need to utilize fully the advantages of titanium bolts in your current airframe projects.

For more information on Hi-Ti titanium aircraft bolts, write Aircraft Products Division, STANDARD PRESSED STEEL Co., Jenkintown 3, Pa.

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AIRCRAFT PRODUCTS DIVISION

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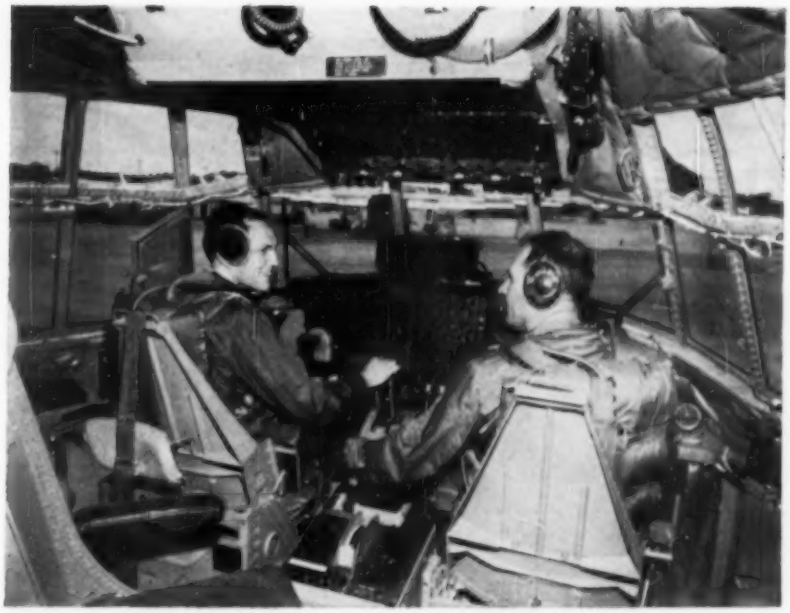

C-130 Cockpit Stresses Visibility

Interior of Lockheed C-130A Hercules cockpit indicates stress on good visibility. Glass area amounts to 40 sq. ft. in the crew area. Besides upper panes, window for downward view can be seen over arm of Lloyd Harris (left), chief pilot, Georgia Division.

Products Laboratory, Forest Service, U. S. Department of Agriculture, for the Wright Air Development Center. $1.00; 34pp. (P.B. 121800).

The Effects of Graded Impedance to Tracheal Air Flow on the Pattern of Breathing and Alveolar Gas Composition of Man.–F. W. Zechman and F. G. Hall, Duke University School of Medicine for Wright Air Development Center. $1.25; 49pp. (P.B. 121565).

Evaluation of Porous Materials for Boundary-Layer Control–by D. E. Debeau, Battelle Memorial Institute for Wright Air Development Center. $4.00; 160pp. (P.B. 121851).

The Relationship of Hardness Measurements to the Tensile and Compression Flow Curves–by R. E. Lenhart, General Electric Research Laboratory for Wright Air Development Center. $1.50; 14pp. (P.B. 121144).

The Silver Oxide-Zinc Alkaline Primary Cell: Part 4, Anodic Characteristics of Zinc Alloys.–by C. M. Shepherd, Naval Research Laboratory. $.75; 25pp. (P.B. 121744).

Automatic Flare-Out for Landing–by D. Markusen, R. McLane and O. Pomeroy, Minneapolis-Honeywell Regulator Company for Wright Air Development Center. $3.75; 146pp. (P.B. 121383).

Flight Test of an Autopilot Installation as a Lateral Gust Alleviator in a PT-26 Airplane–by C. Chalk, Cornell Aeronautical Laboratory for Wright Air Development Center. $2.00; 77pp. (P.B. 121244).

Simulation Study of Control of an Aircraft at or Near the Absolute Ceiling–by A. C. Robinson, J. W. Early and B. J. Doody, Wright Air Development Center. $1.50; 57pp. (P.B. 121459).

Improvements to Time Interrogators and Development of Accessories–by W. E. Haworth, CAA Technical Development Center. $.50; 16pp. (P.B. 121880).

Evaluation of the Resetting Continuous Fire-Detection System for the B-36 Aircraft Nacelle–by L. E. Tarbell, CAA Technical Development Center. $.50; 17pp. (P.B. 121777).

Analysis of the Thermal Properties of Plastic Laminates, Cores, and Sandwich Panels–by R. F. Trapp, Wright Air Development Center. $.50; 18 pp. (P.B. 121882).

Interim Report on Studies of the Effects of Geometry on the Properties of Gun-Metal (88-8-4) Casting–by W. H. Johnson, Naval Research Laboratory. $.50; 8pp. (P.B. 121769).

Investigation of Forged Cobalt Base Alloys for High Temperature Applications–by R. R. MacFarlane, R. K. Pitler, and E. E. Reynolds, Allegheny Ludlum Steel Corp. for Wright Air De-

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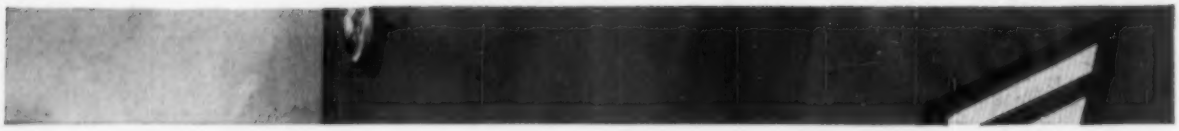
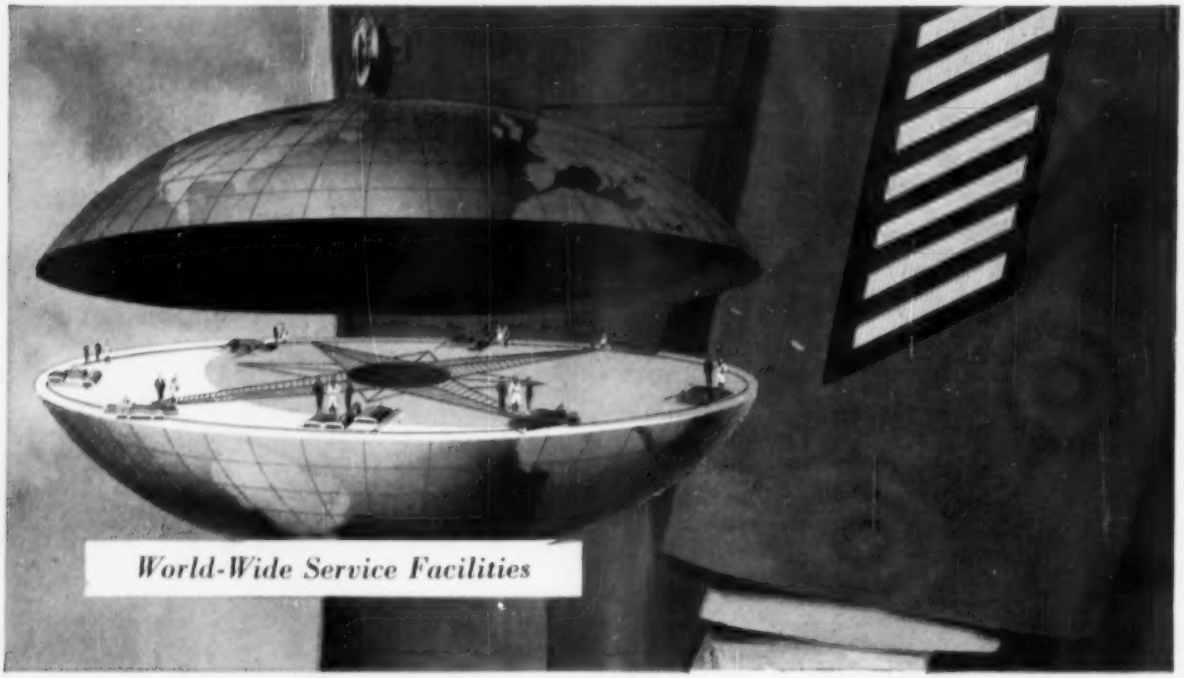


A VETERAN SERVICE ORGANIZATION



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velopment Center. $1.00; 36pp. (P.B. 121723).

Performance Standardization for a Turbojet Engine Equipped with a Variable Area Nozzle Controlled by Engine Speed.–by R. L. O'Neal, Air Force Flight Test Center. $.50; 17pp. (P.B. 121989).

Permanent-Magnet Generators Part I–Theory–by D. J. Hanrahan and D. S. Toffolo, Naval Research Laboratory. $.50; 18pp. (P.B. 121862).

Hismanol, A New Permanent Magnet–by E. Adams, W. M. Hubbard, and A. M. Syeles, Naval Ordnance Laboratory. $.50; 19pp. (P.B. 121730).

Permeability of Barrier Materials to Volatile Corrosion Inhibitors at Various Humidities–by A. S. Mohaupt and J. P. Hohf, Forest Products Laboratories, U. S. Department of Agriculture for Wright Air Development Center. $2.25; 90pp. (P.B. 121893).

Publications Received:

A Case Study in Corporate Acquisition–A Presentation by ACF Industries, Inc. $1.75 ($1.00 AMA members) 42 pp.

A prepared comprehensive, step-by-step presentation of acquisition, corollary acquisition, and integration of different plants, in belief that full details can be most helpful.

Post-War International Civil Aviation Policy and the Law of Air–by H. A. Wassenbergh–Pub. Martinus Nijhoff N. V., 9 Lange Voorhout, Netherlands. 11.50 guilders (approximately $3.00) 180 pp.

A review of the many problems which arise when attempting to reconcile the individual viewpoints of the world's airfaring nations. A valuable source-book for the serious student of air law.

Electrical Construction Materials List–Pub. Underwriters Laboratories, Inc., 161 Sixth Ave., New York 13, New York, 433 pp.

A list composed of all the materials needed for electrical construction work.

Electrical Appliance and Utilization Equipment List–Pub. Underwriters Laboratories Inc., 161 Sixth Ave., New York 13, New York, 391 pp.

A list composed of all the appliances needed for electrical appliance work.

Hazardous Location Equipment List–Pub. Underwriters Inc. 161 Sixth Ave., New York 13, New York. 105 pp.

A list composed of electrical equipment for hazardous locations.

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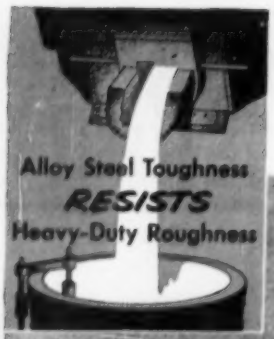
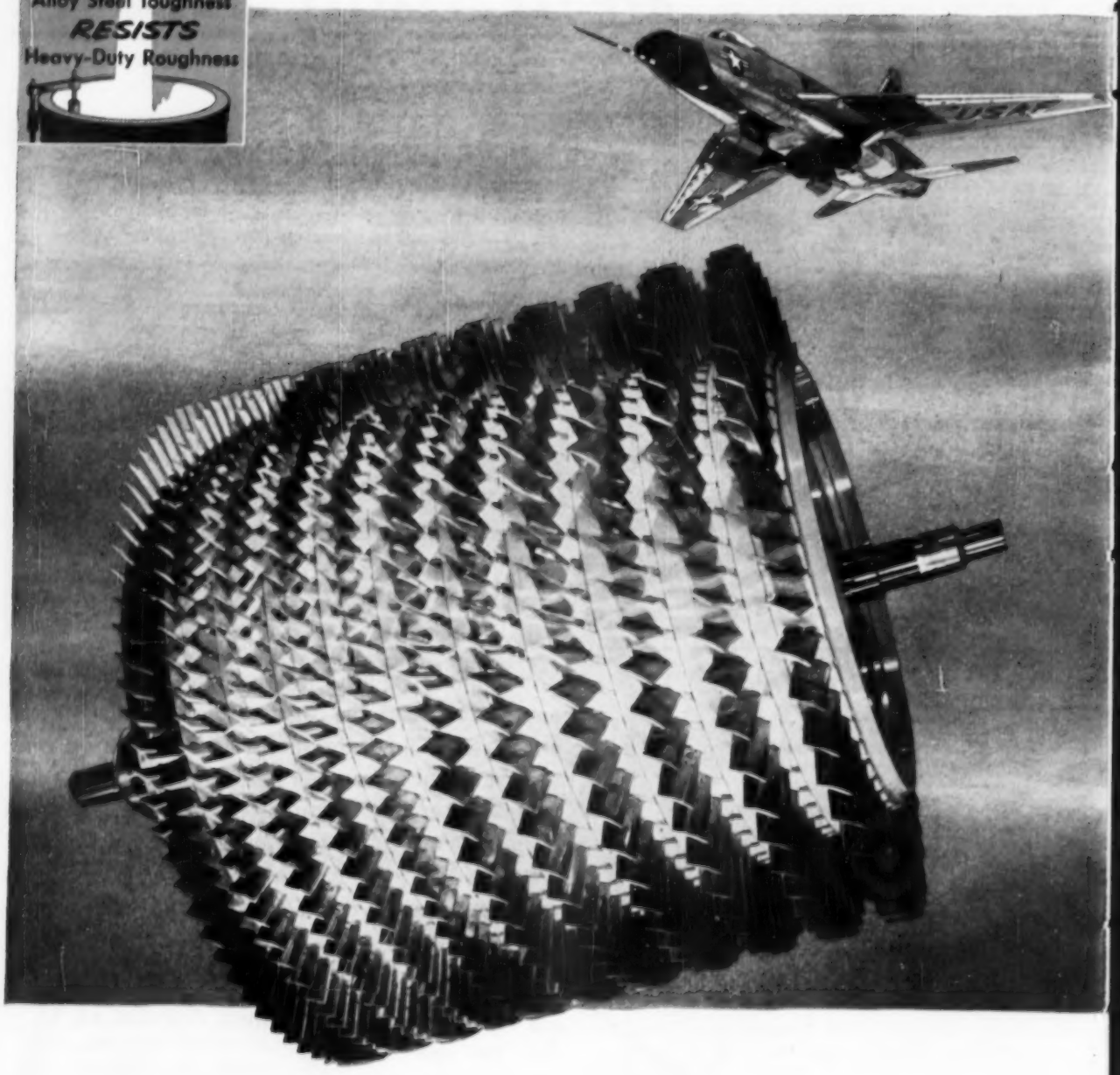


ALLOY STEEL PROVIDES HIGH



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These essential qualities of AMS 6415 were the basis for its selection for use in compressor rotor discs in Pratt & Whitney Aircraft's J-57 jet engine. The discs are machined from forgings by the Jet Division of Thompson Products, Inc. Forgings are supplied by Wyman-Gordon Company.

Still another reason for selection of this fine steel is its exceptionally good deep-hardening characteristics. Uniform response to heat treatment is assured—plus the production of hard, wear-resistant surfaces around tough cores.

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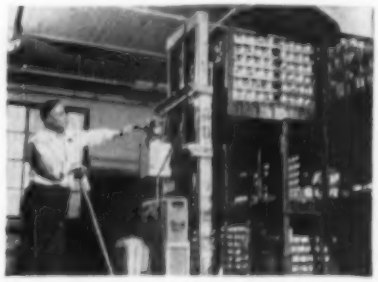

TOUGH, STRONG REPUBLIC STEEL STACKING SKIDS speed piston handling at Thompson Products, Inc. Looking for a way to streamline handling operations and cut costs, Thompson contacted Republic. Joint effort of both companies' engineers produced the design of the PR-15 Stacking Skid, which was then fabricated by Republic's Pressed Steel Division. The result; Thompson enjoys faster, more economical handling in less space and with less equipment. Write for complete details.

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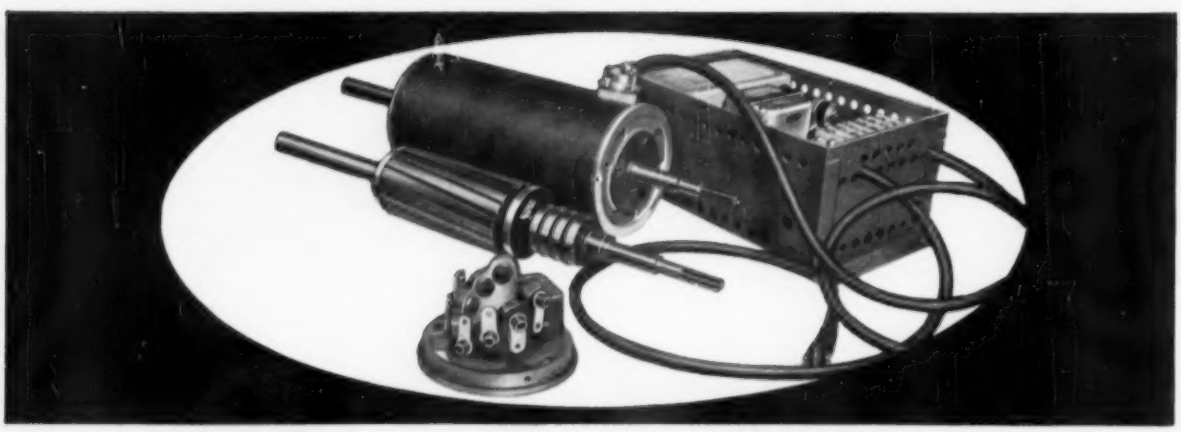
Case History from the files of the Wincharger Corporation

problem: COMPLETELY REDESIGN AN AIRCRAFT ALTERNATOR TO MEET MISSILE WEIGHT AND SIZE REQUIREMENTS



When the Defense Department's missile program went into high gear, Wincharger's Research and Development Group was handed the problem of designing a much smaller, lighter, more compact Alternator. And, along with its smaller size, the Alternator still had to be absolutely reliable.

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Output Voltage	3 ph. 115/208 volts, 400 cycle, 600 watts.
Temperature Rise	Minus 54° C to plus 74° C.
Static Temperature	Minus 46°C to plus 55° C.
Running Duty	Continuous.
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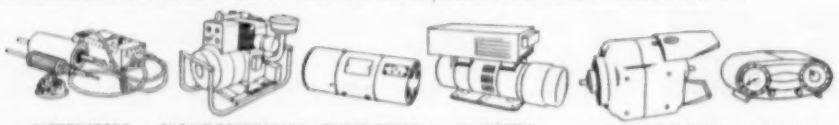

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USAF Contracts

Following is a list of unclassified contracts of $25,000 and over as released by Air Force contracting offices:

SELFRIDGE AIR FORCE BASE, Mich., Purchasing and Contracting office.

G. Toccalino & Sons, 12811 Farmington Rd., Livonia, Mich., construction necessary to repair 13,300 sq. yds. of Portland concrete cement pavement in the taxiways providing access to runways. Project number SLF 65-7 (IFB 20-602-57-80), $112,518.

WRIGHT-PATTERSON AFB, Dayton, Ohio.

Fulfillment Corp. of America, 381 Center St., Marion, Ohio, furnishing services, equipment and supplies for installation of USAF supply catalogs and stock lists, $639,200.

ARDC, P. O. Box 1395, Baltimore 3, Md.

Porter, Urquhart, McCreary and O'Brien, 3568 West Third St., Los Angeles, Calif., preparation of a master plan for Camp Cooke, Calif., AF 18(600)-1663, $81,982.

QUARTERMASTER, RESEARCH & DEVELOPMENT COMMAND, Natick, Mass.

American Power Jet Co., Inc., 705 Grand Ave., Ridgefield, N. J., delivery of fuel by aircraft (Studies) (Negot. DA-19-129-QM-937), job, $58,202.

BASE PROCUREMENT OFFICE, Eglin AFB, Fla.

Bell Construction Co., P. O. Box 1603, Montgomery, Ala., construction of flight line photogrammetric configuration, Range 75 (PR ACM 57-909; IFB 08-603-57-298) $61,100.

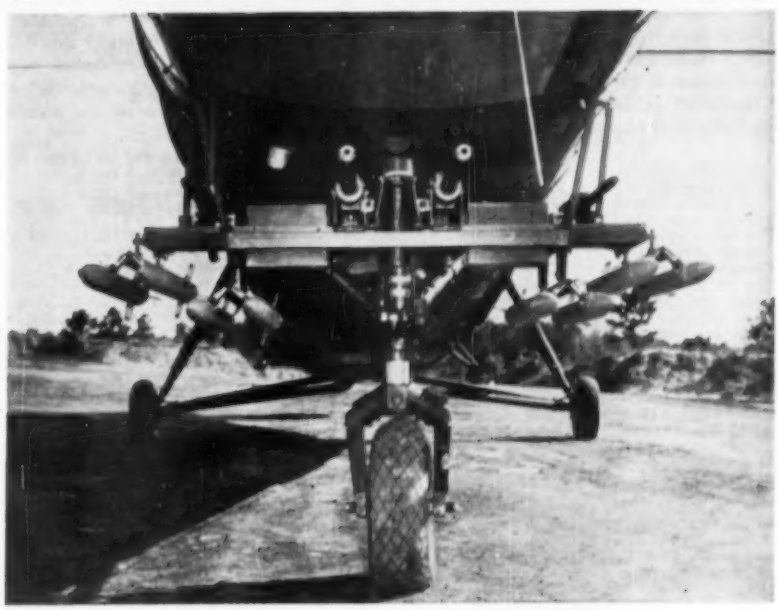
TOPEKA AIR FORCE DEPOT, Topeka Air Force Sta., Topeka, Kans.

Olin Mathieson Chemical Corp., 10 Light St., Baltimore 3, Md., hydraline, anhydrous, 500,000 lb. (IFB 14-604-57-1174) $1,185,000.

MOAMA BROOKLYN AFB, ALA.

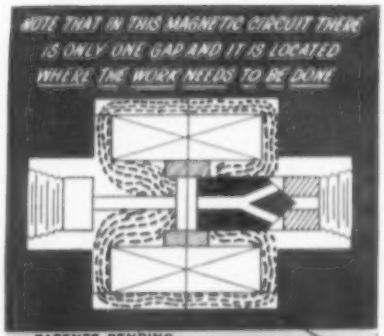
The Aro Equipment Corp., Enterprise & Trevitt Sts., Bryan, Ohio, diaphragm, Aro P/N D2A165, AF 01-(601)20449 Class 63K 27,000 ea., $40,770.

Bendix Aviation Corp., Pioneer-Central Div., 2600-2800 Hickory Grove Rd., Davenport, Ia., oxygen, diluter demand AT 01-



Helicopter Test Fires Rockets

Feasibility of using rockets and machine guns fired from helicopters at ground targets is tested by Army H-21 at Ft. Rucker, Ala. Armament (below) includes eight 80 mm. Oerlikon rockets, two 50 cal. and two 30 cal. machine guns. Firepower packs have been proposed for use on various types of helicopters by General Electric (AW May 20, p. 32).



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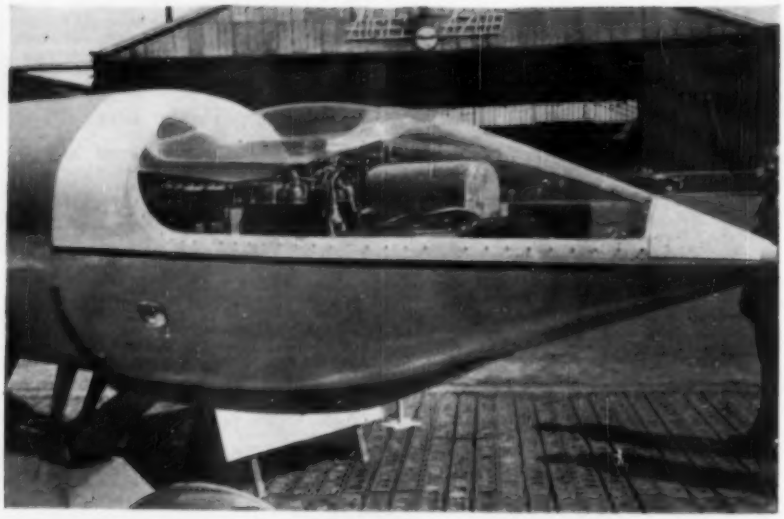

Sweden Buys Jindivik Target Plane

Plastic nose section (top) shows guidance system of Australian Jindivik target drone, of which 10 have been ordered by the Royal Swedish Air Force. The radio controlled target is produced at the Government Aircraft Factory at Fisherman's Bend, Victoria (below). Transparent guidance display was at the recent Paris air show. Cost of the Swedish Jindiviks, including ground control equipment and spares, is $1.4 million.

601-20472-class 03K, 193 ea., $37,799.

Erie Mfg. Co., 4000 S. 13th St., Milwaukee 15, Wis., cylinder assembly emergency oxygen type MD-1 AF 01-601-20447 class 03K 6,700 ea., $115,106.

Alar Products, Inc., 1071 Power Ave., Cleveland, Ohio, outlet gland assy. oxygen regulator, 5100 ea. valve assy. second state relief Aro, 12,300 ea., Gasket-Hi-Pres Tee Aro, 17,600 ea., gasket-interstage Aro, 6,600 ea., elbow-pipe to hose Aro, 15,800 ea., diaphragm second stage alum, 9,300 ea., stirrup oxygen regulator wire steel, 15,200 ea., AF 01-601-20464, class 03K, $31,104.

GADSDEN AIR FORCE DEPOT, Gadsden Air Force Station, Gadsden, Ala.

Protective Coatings Corp., Atlas Package and Container Corp., Div., 596 River Rd., Clifton, N. J., envelope, engine, 6751-306700, (IFB 01-608-57-79B) 3,480 ea., $68,702.

ROME AF DEPOT, Griffiss AFB, N. Y.

Special Design Products Corp., 395 Bayview Ave., Amityville, N. Y., amplifier power (IKW RFP 30-635-57-4305Q), 178 ea., $88,199.

Harvey-Wells Electronics Inc., North St., Southbridge, Mass., antenna coupler CU-547/GR (RFP 30-635-57-5072Q), 714 ea., $769,760.

Mack Electronics Division, Inc., 1120 South Second St., Plainfield, N. J., amplifier modulator group (AN/GRA-24), (RFP 30-635-57-5028Q), 64 ea., $1,367,634.

General Electric Co., Electronics Park, Syracuse, N. Y., oscillator, 11 ea., motor generator, 5 ea., indicator range, 6 ea. (RFQ 30-635-57-4346Q), $87,535.

DAYTON AIR FORCE DEPOT, Gentile Air Force Station, Dayton 10, Ohio.

General Electric Co., French Rd., Utica, N. Y., components of AN/ALT-6B transmitter systems, spares, spare parts, ground support equipment and data, PR: 60021 and 60021-1, $41,744,362.

The Hartman Electrical Mfg. Co., 175 N. Diamond St., Mansfield, Ohio, relay, armature, Hartman P/N A-711KB, 400 ea. coil relay, Hartman P/N 10490-10, 150 ea. solenoid Hartman P/N 6.31-2, 200 ea. relay, solenoid, Hartman P/N B-103D, 100 ea. relay armature, Hartman P/N A-D 800F1, 200 ea. spring, Hartman P/N 7559, 1500 ea. relay, Hartman P/N TD-850 M, 325 ea, PR's MD-7-5945-23609, MD-7-16T-22523, MD-7-16T-22503, MD-7-16T-22535, MD-7-16T-22723, MD-7-5945-23728, MD-7-5945-23697, MD-7-5945-23580, $59,188.

Machlett Laboratories, Inc., 1063 Hope St., Springdale, Conn., tube-electron, type 2C39WA, a/w Spec MIL-E-1/778B (Navy) dtd 29 Apr. 55, 10,000 ea., RFP 33-604-57-2493, $170,500.

Cutler-Hammer, Inc., 410 W. First St., Dayton 2, Ohio, aircraft relays a/w spec MIL-R-6106B (ASG dtd 20 Sept. 55, and amd #2 dtd 27 Jun. 56: AN3343-1, 200 ea., AN3374-1, 400 ea., MS24168-2, 300 ea., MS-24168-1, 100 ea., IFB 33-604-57-64, $63,119.

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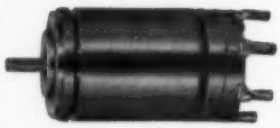
Electrical Characteristics					
Frequency (cps)	400	400	400	400	400
Torque at Stall (oz. in.)	.15	.30	.63	1.45	2.35
No Load Speed (rpm)	6500	6500	6500	5200	5200
Speed at Half Torque (rpm)	4000	4000	4000	3200	3200
Time Constant (sec.)	0.03	0.015	0.016	0.017	0.013
Reversing Time (sec.)	0.051	0.025	0.028	0.030	0.022
Theo. Acceleration at Stall (rad. sec²)	22500	45000	41500	31000	40000
Operating Temp. Range (°C.)	−54 to +125	−54 to +125	−54 to +125	−54 to +125	−54 to +125
Slot Effect	1.8v/26v	1.0v/36v	1.0v/40v	1.0v/40v	1.0v/40v
Duty Cycle	Cont.	Cont.	Cont.	Cont.	Cont.
Fixed Phase					
Voltage	26	115	115	115	115
R (Stall) Ohms	196	1270	1250	490	280
X (Stall) Ohms	183	1560	1780	890	570
Z (Stall) Ohms	268	2210	2175	1030	640
P.F. (Stall)	0.73	0.57	0.58	0.49	0.45
Effective R (Stall) Ohms	366	3840	3800	2160	1460
Parallel Tuning cond. for unity P.F. (Stall) Mfd.	1.0	0.13	0.15	0.33	0.55
Control Phase					
Voltage	40/20	40/20	40/20	40/20	40/20
*R (Stall) Ohms	480	124	145	58	39
*X (Stall) Ohms	445	215	204	103	77
*Z (Stall) Ohms	660	248	250	118	86
*P.F. (Stall)	0.73	0.50	0.58	0.49	0.45
*Effective R (Stall) Ohms	910	495	430	240	190
*Parallel Tuning cond. for unity P.F. (Stall) Mfd.	0.4	1.4	1.3	2.9	4.1
Mechanical Characteristics					
Rotor Inertia (gm. cm²)	.47	.47	1.07	3.3	4.0
Weight (oz.)	1.2	2	4.5	8	14
Mounting Type	Synchro	Synchro	Synchro	Synchro	Synchro
Motor Length	.863	.672	1.703	1.625	2.03
Type Shaft	Pinion	Pinion	Plain	Plain	Plain
Shaft Extension	.375	.218	.437	.540	.540
Outside Diameter	.750	.937	1.062	1.437	1.750
Type Connection	Leads	Terminals	Terminals	Terminals	Terminals

*For 40v connection

Size 8

Size 10



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Size 18

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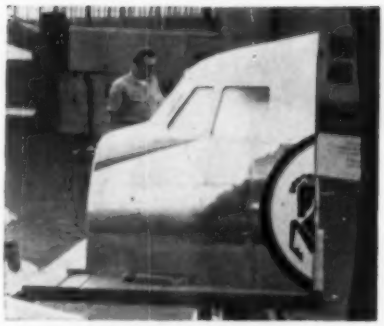

Simulator Airfreighted

This electronic flight simulator for Air France's Lockheed 1649A Super Star Constellations is being loaded aboard a Seaboard & Western 1049D cargo Super Constellation for a nonstop flight from New York International Airport to Air France's headquarters at Orly Field, Paris. First transatlantic air shipments of these Curtiss-Wright flight simulators to European airlines—via routes they will reproduce electronically many times over—were begun recently to Air France, KLM Royal Dutch Airlines and Lufthansa-German Airlines flight crew training centers. The Air France simulator weighed 32,000 lb. and was insured for $1,400,000, believed by the insurors to be the highest insured cargo ever commercially transported by air.

St., Joliet, Ill., relay, armature, P/O jcens radio set AN/URN-5, Phillips Control #2MS17A1, 200 ea., relay, Barber-Coleman P/N CYZ186 Mfg. by Phillips Control Corp., P/N43005-1 or type 27QA14P1. Appl: controls 4259-CYLZ2784-1 and 4259-CYIZ2793-2 4259-CYLZ2784-1 and 4259-CYIZ2793-2, installed on B-50 & C-97 aircraft, 800 ea., RFP 330604-57-2561, $35,810.

Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif., oscillograph-recording, CEC Inst. model 5-114P3-18, 7 ea., RFP 33-604-57-2764, $31,885.

Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J., millivoltmeters, portable, a.c. d.c. Weston model 455, 100 ea., wattmeter, portable a.c. d.c., 19 ea. PR: MD-7-17C-80765, MD-7-17C-80762, MD-7-17C-80766. $42,194.

Bird Electronic Corp., 1800 E. 385th St., Cleveland 14, Ohio, element, detacting P/O Mod 43 wattmeter, 1,600 ea., PR-MD-7-17C-90071, $32,960.

Cutler-Hammer, Inc., 410 W. First St., Dayton 2, Ohio, switch actuator adapters & sensitve switches a/w spec MIL-S-644 dtd 14 Jun. 59, MS 25039-1, 7795 IFB 33-604-57-46, $26,347.

Cutler-Hammer, Inc., 410 W. First St., Dayton 2, Ohio, toggle switches a/w MIL-S-6745 dtd 14 Jun. 50 & amd #3 dtd 4 Oct. 54: AN3022-2, 20,000 ea., AN3027-2, 15,000 ea.,AN3227-5, 10,000 ea., MS25068-1, 800 ea., IFB 33-64-57-55, $46,043.

Garrett Corp., Airesearch Mfg. Corp. Div., 9951 Sepulveda Blvd., Los Angeles 45, Calif., repair, overhaul, and/or modification of thermostatic controls, $206,855.

Electronics of Clearfield Div. of Progressive Pub. Co., Inc., P. O. Box 792, Clearfield, Pa., pulse generator set AN/UPM-15 a/w MIL-P-6324A, IFB 33-604-57-258, $105,942.

Thomas A. Edison Industries, McGraw-Edison Co., Div., 51 Lakeside Ave., West Orange, N. J., relay, thermal time delay, 18,700 ea. (PR 741089 & 741089-1) $128,006.

International Telephone & Telegraph Corp., Farnsworth Electronics Co., Div., Fort Wayne, Ind., range calibrator sets, AN/UPM-11A, 122 ea., delay line, MX-1340/UPM-11A, 900 ea., delay line, MX-1300/UPM-11A, 50 ea., delay line, MX-1301/UPM-11A, 22 ea., delay line, MX-1302/UPM-11A, 22 ea. (PR'S MIPR R57-128-29069E 2/6/ASO MD-7-170-80100, MD-628262, MD628432) $345,200.

Leach Corp., Leach Relay Div., 5615 Avalon Blvd., Los Angeles 3, Calif., relay, solenoid SPST a/w Spec Nr. MIL-R-6106B, 2,775 ea., relay armature, DPDT, a/w Spec Nr. MIL-R-6106B, 3,000 ea., (IFB 33-604-57-238) $54,327.

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass., bridge, capacitance, Type #716 CM, 10 ea., box decade capacitance, Type No. 219K, 76 ea., bridge resistance, Type 544B, 5 ea., bridge impedance, Type 1606A, 5 ea., bridge, inductance, Type #716 CM, 20 ea., resistor, decade 0 to 111 ohms, P/N 1432F, 10 ea., resistor, decade 0 to 11110 ohms, P/N 1432J, 109 ea., (RFP 33-604-57-2185) $53,240.

Magnatran, Inc., P.O. Box 311, Kearney, N. J., retrofit modification kit to modify transformer T-202, 22 ea. (RFP 33-604-57-2268) $54,720.

MEMPHIS AIR FORCE DEPOT, Mallory Air Force Station, 3300 Jackson Ave., Memphis, Tenn.

General Motors Corp., New Departure Div., Bristol, Conn., bearings (IFB 40-604-57-2027), 134,554 ea., $91,227.

Marlin-Rockwell Corp., 402 Chandler St., Jamestown, N. Y., bearings (IFB 40-604-57-485), 32,000 ea., $58,880.

WARNER ROBINS AIR MATERIEL AREA, U.S. AF Robins AFB, Ga.

Northrop Aircraft Inc., 1001 E. Broadway, Hawthorne, Cal., rocket detent tube steel (PR-634032) 14237 ea., $190,633.

MIDDLETOWN AIR MATERIEL AREA, USAF, Olmsted AFB, Pa.

Gas Industries Inc., P.O. Box 538, Allentown, Pa., liquid oxygen and liquid nitrogen, sole source, PR-MA-662953 and MA-662053-1, 3,800 tons, $552,750.

Minneapolis-Honeywell Regulator Co., 2600 Ridgeway Road, Minneapolis 13, Minn., capacitor, amplifier, RFP PR MA-563810, 1,106 ea, $116,967.

Instrument Dept., General Electric Co., 40 Federal St., West Lynn, Mass., kit, RFP PR MA-597750. 700 ea, $64,060.

Simmonds Aerocessories, Inc., 105 White Plains Rd., Tarrytown, N. Y., transmitter, tank unit, IFB PR MA-563810, 673 ea, $109,091.

Mills Manufacturing Corp., P. O. Box 8068, Asheville, N. C., parachute, personnel, 28 ft. P/N 50C7023-9; IFB PR MA-564180 and 564180-1, 10,091 ea., $1,271,768

Decker Aviation Corp., 1361 Frankford Ave., Philadelphia 25, Pa., indicator (RFP PR MA-7-05C-97) 2,600 ea., $50,968.

The Liquidometer Corp., 41-05 36th St., Long Island City 1, N. Y., indicator, transmitter (RFP PR MA-563822) 1,216 ea., $66,677.

SHELBY AIR FORCE DEPOT, Wilkins Air Force Station, Shelby, Ohio.

American Air Filter Co., Inc., Herman Nelson Div., 215 Central Ave., Louisville 8, Ky., type H-1 heater, engine and shelter (MH-654863-1/936-1 693224, -1, 698983), 3227 ea., $5,063,259.

Wells Industries Corp., 6880 Troost Ave., North Hollywood, Calif., truck-aeft main landing gear and nose landing gear (IFB 33-602-57-82) 15 ea., $65,851.

Screw Machine Products Co., 7737 N. E. Killingsworth, Portland 20, Ore., maintenance platform 8 ea., (MH-606675) $74,386.

Continental Aviation & Engineering Corp., 12700 Kercheval Ave., Detroit 15, Mich., kits modification type MA-1 compressor, air gas turbine 1525 ea. (MH-7-19A-167) $418,734.

O. E. Szekely & Associates, Inc., Box 269, Commerce, Ga., trailers, aircraft engines (IFB 33-602-57-30) 2,130 ea., $1,314,465.

Air Logistics Corp., 3600 E. Foothill Blvd., Pasadena, Calif., trailers, aircraft

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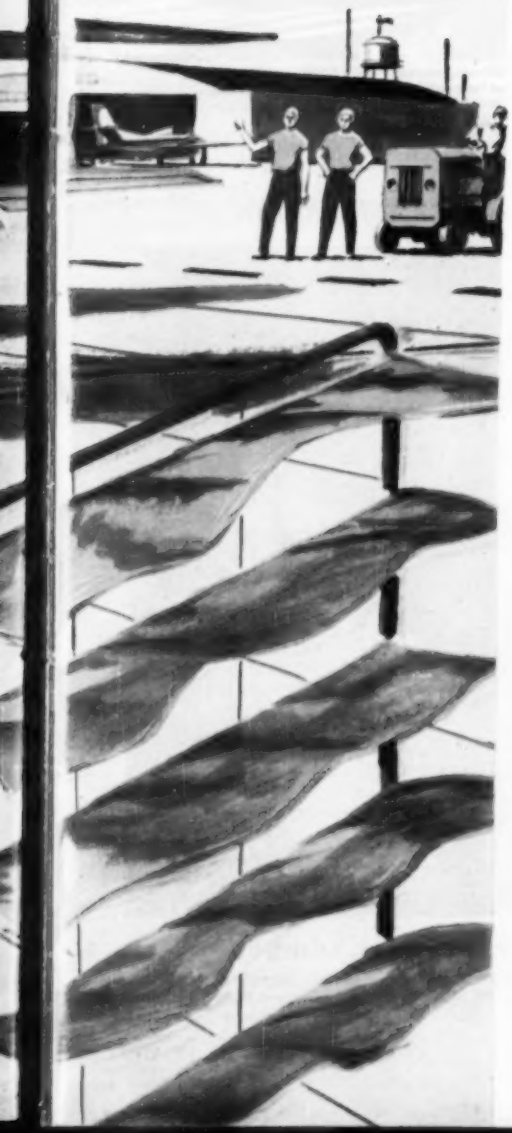

New Westinghouse J34 engine powers first Navy all-purpose jet trainer

North American Aviation has chosen the new version of a proven power plant for this first Navy all-purpose jet trainer. Designed as a complete pilot training system for operation from both land and carrier bases, the T2J-1 is capable of taking students from primary through advanced phases to carrier qualification.

Engineered and designed after Pearl Harbor, the J34 turbojet saw rugged service in Korea. Its early reputation for combat reliability and durability has now become almost legendary after more than two million hours of combat and operational flight time. It is less than half as vulnerable to foreign object damage as other engines. No wonder the Westinghouse J34 was selected to power this new all-purpose jet trainer!

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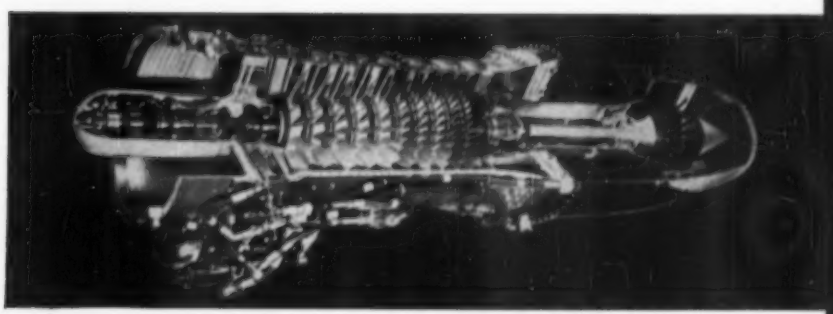
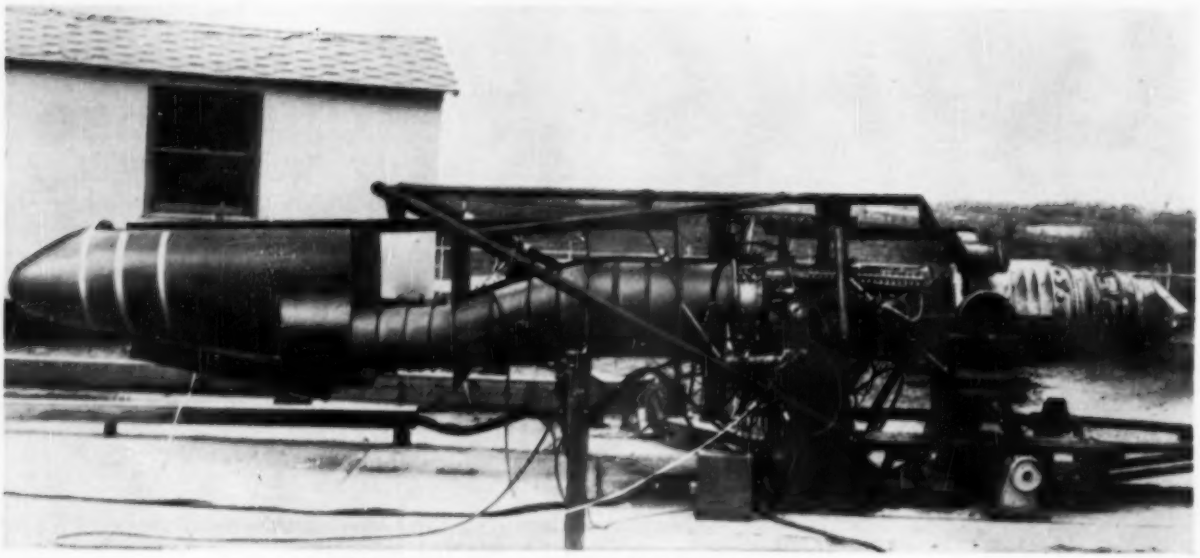


The Westinghouse J34-WE-46 will produce 3,400 pounds thrust to give the T2J-1 a level flight speed of 429 kt.



J34 Engine Tested With T2J Duct

Compatibility tests of the Westinghouse J34-WE-46 engine and the North American T2J-1 trainer inlet duct were carried out using this rig at the Naval Air Station, Olathe, Kan. The engine is shown mounted in an outdoor thrust cradle. Completion of the first T2J is expected late this year. Engines will be manufactured at Westinghouse's plant in Kansas City, Mo.

engine (IFB 33-602-57-30) 1,907 ea., $1,294,516.

Air Logistics Corp., 3600 E. Foothill Blvd., Pasadena, Calif., kit-modification of models 2000-3000 trailers (MH-7-19G-207-1) 668 ea., $31,385.

Flexible Tubing Corp., New Whitfield St., Guilford, Conn., hose, air duct (IFB 33-602-57-208) 2,000 ea., $63,520.

U. S. Rubber Co., 21 Market St., Passaic, N. J., hose aircraft (IFB 33-602-57-208) 100,000 ft., $35,120.

Shielding, Inc., 8 Reserve St., Riverside, N. J., shield-test cubical shape. (IFB 33-602-57-217), 24 ea., $34,320.

Mid States Ornamental Iron Co., 5321 E. 9th St., Kansas City 24, Mo., truck-Aircraft eng. trans. (IFB 33-602-57-189), 51 ea., technical data, $90,315.

Seymour Wallas & Co., 1200 S. 8th St., St. Louis 4, Mo., bag assy., cotton duck, center folding type, type B-4B, (IFB 33-602-57-184), 28,305 ea., $417,102.

Bristol Mfg. Corp., Buttonwood Ave., Bristol, R. I., boot, flying, man's, rubber, type A-17, (IFB 33-602-57-221), 6,035 pr., $51,659.

AIR FORCE MISSILE TEST CENTER, Patrick AFB, Fla.

Radiation, Inc., Melbourne, Fla., monitor mixer unit TLM-35, Eighteen(10), (P.R. 57-1275), $114,000.

Dalton-Hedge Radio Supply Co. Inc., 912 W. Fourth St., Winston-Salem, N. C., voltmeter, 7CAC-NL919972-35 (PR 17C-III-LP-57-32892), 8 ea, $26,000.

Boonton Radio Corp., Intervale Rd., Boonton, N. J., generator, 8CAC-NL318500-45 (PR 17C-III-LP-57-32361), 16 ea, $25,534.

Milgo Electronic Corp., 7601 N.W. 37th Ave., Miami, Fla., digital data receiver, four, (P.R. 57-1188), $50,654.

Telecomputing Corp., 16217 Lindberg St., Van Nuys, Calif., theodolite film readers, two, (PR 57-1088), $98,170.

OPTOmechanisms Inc., 216 E. Second St., Mineola, L. I., N. Y., interferometer comparator, (PR 57-1132), $136,628.

OKLAHOMA CITY AIR MATERIEL AREA, Tinker AFB, Okla.

Boeing Airplane Co., Wichita, Kans., modification and proto-typing of one B-47 airplane into the KB-47 Tanker Configuration, (OC-729507) $887,000.

Mid-States Mfg. Co., Division of Hello Aircraft Corp., Pittsburg, Kans., bracket-fastener. (IFB 34-601-57-287-OC-705/898) $85,675.

New York Air Brake Corp., Starbuck Ave., Watertown, N. Y., pump—Axial Pistons (OC-691281) $100,626.

Bendix Products Div., Bendix Aviation Corporation, South Bend, Ind., overhaul of control assemblies & valves assemblies (OC-730176), $88,111.

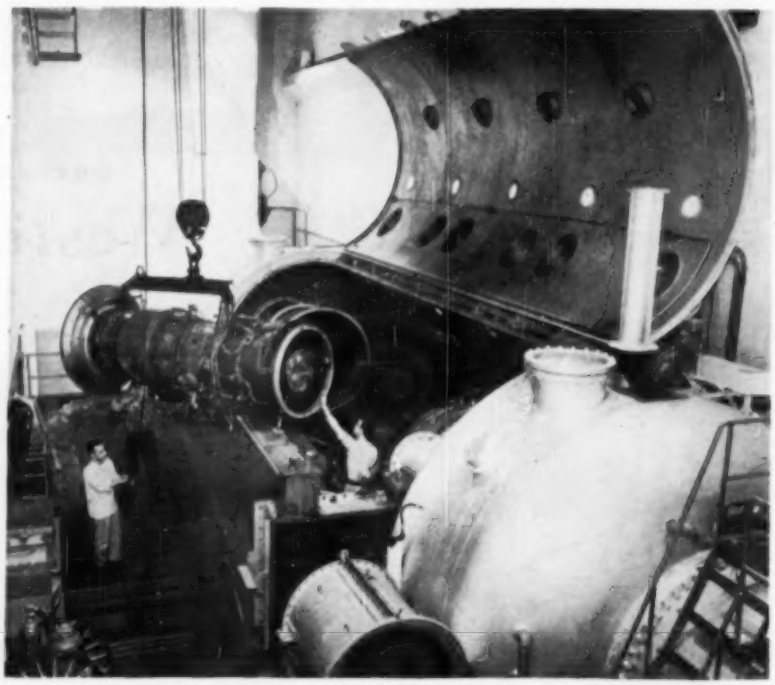
Aero Supply Manufacturing Co., Inc., 611 West Main Street, Corry, Pa., strainer assembly, fuel system. (OC-691189), 10 items, $116,130.

Aero Design and Engineering Co., P.O. Box 118, Bethany, Okla., maintenance and modification of eleven (11) ea. L-26B type aircraft. (OC-7-01AVL26-MC2173), $18,329.

David Clark Co., Inc., 360 Park Ave., Worcester 2, Mass., cap and fitting. (OC-665341), 9 items, $28,486.

Bendix-Skinner Div., Bendix Aviation Corp., P.O. Box 135, Royal Oak, Mich., valve assembly hyd. check. (IFB 34-601-57-224-OC-733103), 1 item, $70,403.

Allied Ordnance Corp., 15 Wright Ave., Jersey City 6, N. J., valve air high pressure



J57 Lifted Into Altitude Chamber

Pratt & Whitney J57 turbojet is hoisted into an altitude test chamber at the Willgoos Laboratory where conditions from sea level to 70,000 ft. are simulated.

NOW FROM FORD INSTRUMENT ALL-SILICON-TRANSISTORIZED EXHAUST TEMPERATURE INDICATOR

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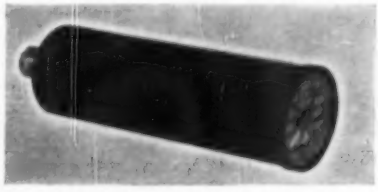

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We welcome inquiries regarding projects in any and all areas of our proved competence. Write, call or wire Burroughs Corporation, Defense Contracts Organization, Detroit 32, Michigan. Or Burroughs Defense District Offices: Paoli, Pa. • Dayton, Ohio, 3898 Linden Ave. • Encino, Calif., 17071 Ventura Blvd. • Washington, D.C., 1145 Nineteenth Street N.W.

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(IFB 34-601-57-224-OC-733102), 1 item, $85,426.

Aero-Motive Manufacturing Co., 1803 Alcott Street, Kalamazoo, Mich., seat assembly valve, (RFP 310-031-1-OC-665340), 4 items, $27,889.

OGDEN AIR MATERIEL AREA, Hill AFB, Utah.

Northrop Aircraft, Inc., Hawthorne, Calif., conversion of F-89C aircraft to tow aircraft, (request 00-757512, 00-761176, 00-761176-1), $386,622.

B. F. Goodrich Aviation Products Div., The B. F. Goodrich Company, 500 South Main Street, Akron 18, Ohio, spare parts for brakes for F-84 aircraft. (request 00-787397), $131,791.

Radioplane Company, 8000 Woodley Ave., Van Nuys, Calif., cable assy, rear junction box to aileron gyro servo, battery assy, radioplane, detonator assy, JATO aerial target catapult. (IFB 42-600-57-271), $39,950.

Goodyear Tire & Rubber Co., 1144 E. Market St., Akron, Ohio, spare parts for wheel and brakes applicable to L-23, T-28, T-29, F-84 and F-89 Aircraft, $625,864.

Westinghouse Air Brake Co., Union Switch & Signal Div., Swissvale, Pa., modification of 12 MB-23C (F-86D) Flight Simulators, $940,232.

Axelson Manufacturing Co., Div. of U. S. Industries, Inc., 6160 S. Boyle Ave., Los Angeles 58, Calif., component parts for landing gear assy, applicable to T28 aircraft, (P.R. 00-7-03G-299 and -1), $96,784.

SAN ANTONIO AIR MATERIEL AREA, USAF, Kelly AFB, Tex.

Airtron, Inc., 1101 West Elizabeth Ave., Linden, New Jersey, aircraft accessory spare parts, 9 items. PR: SA-639733 and SA-639733-1, $55,966; aircraft accessory spare parts, 8 items. PR SA-639719 and SA-639719-1, $74,973.

Adel Precision Products Div., General Metals Corporation, 10777 Vanowen St., Burbank, Calif., aircraft accessory spare parts, 31 items. PR SA-729055 and SA-729053, $173,725.

Cooperative Industries, Inc., 100 Oakdale Road, Chester, N. J., aircraft accessory spare parts, 5 items. PR SA-639719 and SA-639719-1, $27,367.

Romec Div., Lear, Inc., Abbe Rd., Elyria, Ohio, 4275-IS14401 motor (Lear-Romec, P/N RD-9221-2) 114 ea. and 4275-IS14482 motor (Lear-Romec, P/N RG-10179) 84 ea. PR: SA-715468, $43,281.

Jack and Heintz, Inc., 17600 Broadway, Cleveland 1, Ohio, 4224-G32-6D starter-generator, 48 ea. and revision to overhaul instructions 35C2-3-89-3 and revision to illustrated parts breakdown 35C2-3-89-4. PR: SA-729490, $29,205.

Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles 6, Cal., aircraft accessory spare parts, PR: SA-639689 and SA-639689-1, $149,809.

Electrical Engineering & Mfg. Corp., 4612 W. Jefferson Blvd., Los Angeles 16, Calif., actuator assy, S/N4290-D458, 46 ea. and actuator assy., S/N 4290-D460, 148 ea., PR: SA-715473, $80,592.

Continental Aviation Engineering Corp., 1330 Laskey Rd., Toledo, Ohio, aircraft accessory spare parts PR: MIPR R55-468-2654, $37,039.

AIR FORCE CAMBRIDGE RESEARCH CENTER, Laurence G. Hanscom Field, Bedford, Mass.

Ohio State University Research Foundation, Columbus, Ohio, research directed toward the study of thermal radiation methods of atmospheric probing—AF19-(604)-2259—$35,101.

Boston College, Chestnut Hill, Mass., research directed toward the study of the properties of a plasma that may lead to a new type of EM generator—AF19—(604)-2195—$49,999.

Cornell Aeronautical Laboratory, Inc., 4455 Genesee St., Buffalo, N. Y., research and test program investigating contrail formations, AF19 (604)-2257, $29,656.

University of Tennessee, Knoxville, Tenn., research directed toward the experimental study of infrared spectral line shape AF19 (604)-2281, $25,161.

Allied Research Associates, Inc., 43 Leon St., Boston, Mass., experimental studies of the physical properties of chemicals, AF19 (604)-2268, $40,110.

President and Trustees of Bowdoin College, Brunswick, Me., investigation of more effective disciplines on design of secrecy systems for USAF, AF 19(604)-2226, $47,704.

Fairchild Controls Corp., 2 Aerial Way, Syosset, L. I., N. Y., design, fabricate, install and test 12 radar moving target simulators, AF19 (604)-2643, $74,425.

Trustees of Tufts College, Medford, Mass., design and development of Balloon Carrier System, AF19 (604)-2647, $245,000.

Navy Contracts

NAVY PURCHASING OFFICE, Washington, D. C. 4th & Independence Ave., S. W.

Hamilton Standard Div. United Aircraft Corp., Windsor Locks, Conn., air turbine starter HSD model 300-31, PN 515488, 165 ea, air turbine starter HAD model 300-31, P/N 515489-174 QAD disconnect HSD P/N (1) 519784 adapter and (1) 519801 clamp, 174 ea (N600(A)44996) (IFB600-1474-57) $973,840.

AVIATION SUPPLY OFFICE, 700 Robbins Ave., Philadelphia, Pa.

Air Logistics Corp., 3600 Foothill Blvd., Pasadena, Calif., jet engines installations and removal trailers, (JD-383/29065-1738, 3/3/57 Aero) $627,695; heavy duty transportation trailers (JD-383/29065-1738, 3/3/57) $248,802.

Aeroil Products Co., Inc., 69 Wesley St., S. Hackensack, N. J., oxygen servicing trailers, (IFB 383-1963-57), $238,521.

General Electric Co., 3 Penn Center Plaza, Philadelphia, Pa., cable and thermo assemblies, (383/2118-127/55 Aero), $105,277.

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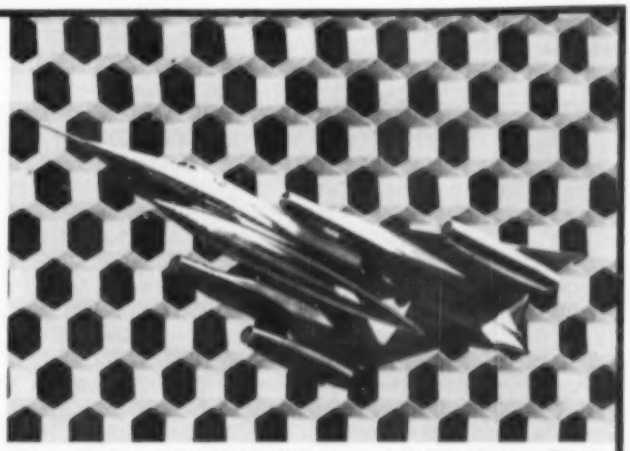
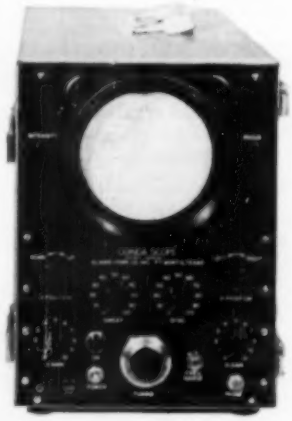
COINDA-SCOPE

(Model 101—Portable)





PROVEN (in production of Convair's B58 Hustler) TO BE THE MOST SUCCESSFUL AND ACCURATE BOND ANALYZER IN THE INDUSTRY TODAY . . . Self-contained and portable . . . Minimum Operator Training Time . . . Simplified Operation . . . Versatile in Production Line, Field Inspection and Lab Inspection Use!

WRITE TODAY FOR DETAILS!

ALMAR-YORK CO., Inc.,

4802 Camp Bowie Blvd., Fort Worth, Texas

"Manufacturers of Custom Test Equipment of ALL Types"

Corp., Great Neck, L. I., N. Y., radar test sets, (383/27164-4-E 2/6/57), (383/9564-88/57), $907,592.

Flight Refueling, Inc., Friendship International Airport, Box 1701, Baltimore 3, Md., assemblies and maintenance parts, (JD-383-2110-374/55 Aero), $462,250.

Bendix Products Div., Bendix Aviation Corp., 401 Bendix Dr., South Bend 20, Ind., maintenance parts, (383/2118-2829/53 Aero), $202,060.

Henry Spen & Co., Inc., 1995 Pitkin Ave., Brooklyn, N. Y., air of nitrogen servicing trailers, (IFB 383-2085-57), $181,245.

Aero Test Equipment Co., Inc., 2615 W. Mockingbird Lane, Dallas 35, Texas, motor generators, (IFB 383-2077-57), $160,997.

L. W. Foster Sportwear Co., Inc., Hancock & Westmoreland Sts., Philadelphia 40, Pa., vest and groin protectors, (IFB 383-2053-57), $057,913.

Bendix Products Div., Bendix Aviation Corp., 401 Bendix Dr., South Bend 20, Ind., pump assemblies and master controls, (383/2116-227/53 Aero), $1,048,391.

Jetronic Industries, Inc., Main & Cotton Sts., Philadelphia 27, Pa., radar test sets, (IFB 383-2063-57), $146,016.

Vertol Aircraft Corp., 100 Woodland Ave., Morton, Pa., HUP spares (383/2110-5057 A 5/2/55), $804,765.

Henry Spen & Co., Inc., 1995 Pitkin Ave., Brooklyn, N. Y., regulators, (383/29065-186 S 3/3/57 Aero), $132,096.

Master Specialties Co., 956 E. 108th St., Los Angeles, Calif., parachutes, (IFB 383-1976-57), $195,845.

Bendix Products Div., Bendix Aviation Corp., 401 Bendix Dr., South Bend 20, Ind., assemblies and maintenance parts (383/2150-592 X 4/1/55), $177,351.

Army Contracts

Following is a list of unclassified contracts for $25,000 and over as released by Army contracting offices:

ARMY SIGNAL SUPPLY AGENCY, 225 S. 18th St., Philadelphia 3, Pa.

Hazeltine Corp., Little Neck, L. I., N. Y., radar set, AN/TPS-25 (XE-1) Contract number 66411 (PR&C 57-ELE/D-5414) $400,000.

Georgia Tech Research Institute, Atlanta, Ga., combat surveillance radar, contract number 74870 (R&C 57-ELE/D-2818) $832,236.

Beiser Aviation Corp., Fort Huachuca, Ariz., organizational and field maintenance of Army aircraft, modification. Contract number 68020 (PR&C TR-PR-53-57) $343,-081.

Republic Aviation Corp., Mineola, L. I., N. Y., surveillance drones and related equipment in accord with TR-BASD-6-57. Contract number 75552 (PR&C MPA-231-57) $1,700,193.

Rheem Manufacturing Co., Downey, Calif., surveillance drones and related equipment in accord with TR-BASD-6-57. Contract number 74324 (PR&C MPA-231-232-57) $1,611,376.

REDSTONE ARSENAL, Huntsville, Ala.

Linde Air Products Co., 2900 Cahaba Road, Birmingham, Ala., liquid oxygen, in tank cars, (purchase request: ME-10268-57), $49,500.

Emerson Electric Manufacturing Co., 8100 Florissant Ave., St. Louis, Mo., classified (purchase request: CS-43-57), $197,397.

ARMY ORDNANCE DISTRICT, Los Angeles, 55 S. Grand Ave., Pasadena, Calif.

Douglas Aircraft Co., 3000 Ocean Park Blvd., Santa Monica, Calif., missile technical representative services, $1,670,064.

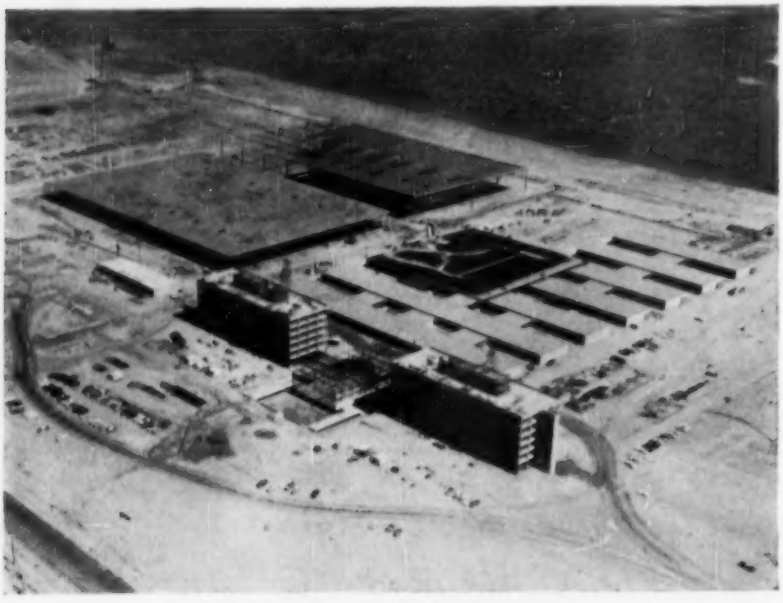
CORPS OF ENGINEERS, NEW ENGLAND DIV., 150 Causeway St., Boston 15.

Phillip W. Genovese & Associates, 294-296 Elm St., New Haven, Conn., design of Nike items (FY-1957), Bridgeport and Hartford defense areas, vicinity of Bridgeport and Hartford, Conn., (DA-19-016-ENG-5348) $55,000.

CORPS OF ENGINEERS, PHILADELPHIA DISTRICT, Philadelphia, Pa.

Edward R. Ellis & Sons, Inc., Route 70 at Harvard Ave., Merchantville, N. J., construction of passenger air terminal addition at McGuire AFB, Wrightstown, N. J., contract No. DA-36-109-ENG-6548, $165,000.

Araco Co. & Kimberly Construction Co., Inc., (joint-venturers) 922 W. Courtland St., Philadelphia, construction of ammunition storage facilities ADC Type at McGuire AFB, N. J. contract No. DA-36-109-ENG-6554 $1,073,499.



Atlas Plant Takes Shape

New $40 million plant near San Diego for production of Convair Atlas intercontinental ballistic missile takes shape. Six story structures in foreground are engineering building (left) and administration. Factory is at upper left, laboratories right center.

Exciting new things are happening at

HOFFMAN ELECTRONICS

Out of advanced electronics research and development at Hoffman comes an entirely new concept in ground radar. Still under wraps by the Military, this unusual and practical Hoffman development applies revolutionary techniques to solving complex weapons systems problems.

Hoffman's extensive experience in designing, developing and producing radar for airborne and shipboard installations laid the groundwork for this exciting new electronics development. In radar, as in other vital military and commercial fields—countermeasures, navigation, weapons and communications systems—Hoffman continues to produce the pattern for progress in electronics.

In a dynamic industry where only change is permanent, exciting things continue to happen at Hoffman.

PHYSICISTS • ELECTRONICS AND ELECTRO-MECHANICAL ENGINEERS

Significant new developments at Hoffman in the fields of navigation, VLF, HF, VHF, UHF, radar, ECM, weapons systems and semiconductors have created important positions for scientists and engineers of high calibre. Please address inquiries to Chief Engineer.

Hoffman Electronics

HOFFMAN LABORATORIES, INC.
3761 South Hill Street
Los Angeles 7, California

"radar's caught infiltration on hill four zero..."
As at sea and in the air, Hoffman-developed radar now gives our Armed Forces greatly extended capabilities for surveillance on the battlefield. It's another outstanding example of...
Hoffman Electronics
Where exciting new things are happening in RADAR
HOFFMAN LABORATORIES, INC.
3761 South Hill Street
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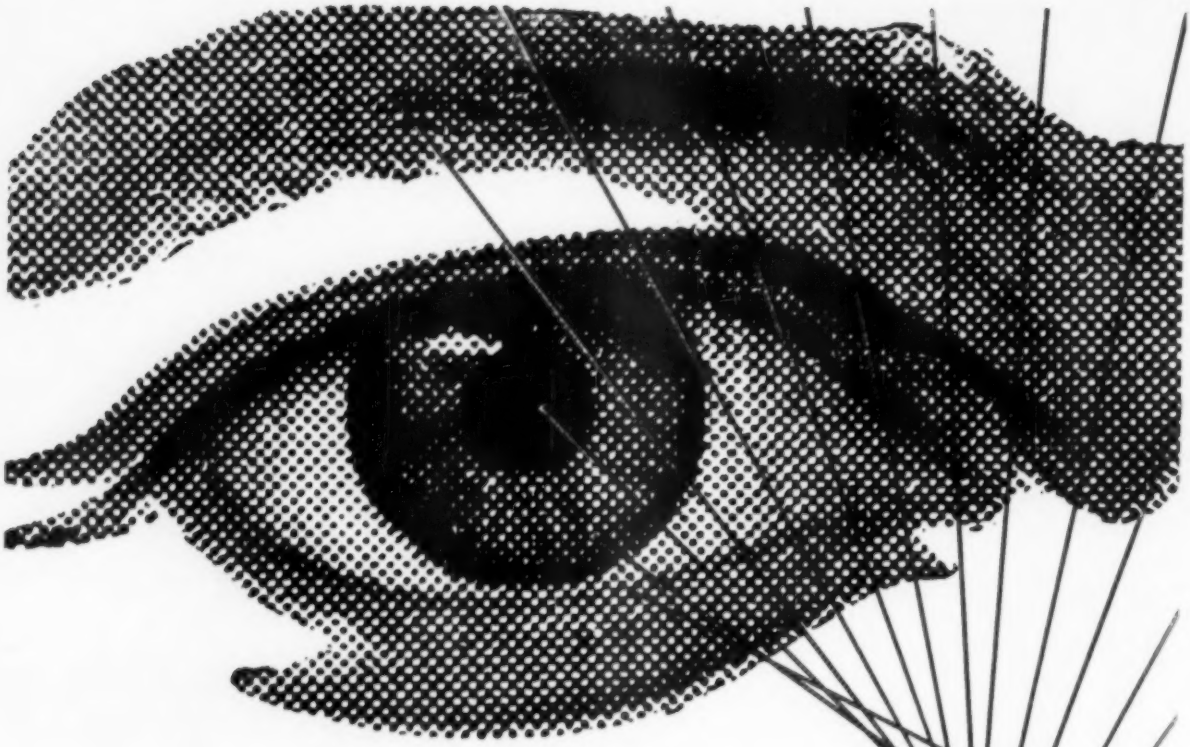
RESEARCH,
DEVELOPMENT & PRODUCTION
WEAPONS SYSTEMS
COMMUNICATIONS
NAVIGATION
ELECTRONIC COUNTER MEASURES
RADAR
SEMICONDUCTOR APPLICATIONS



endowed with sight ...and insight

Inquisitive eyes denote the inquisitive minds that made possible today's rocket powerplants. Sharp eyes and minds that have the power to visualize challenging problems . . . *and* the insight to solve them.

Spurred by such long-range sight and insight, RMI has blazed the trail in rocket power for over fifteen years. And today, with new developments in manned and guided flight creating vast new propulsion problems, RMI will continue to lead the way. For RMI engineers and scientists form a talented, far-sighted team, designing and producing advanced powerplants for the vehicles of tomorrow.

Engineers, Scientists—Perhaps you, too, can work with America's *first* rocket family. You'll find the problems challenging, the rewards great.

Power for Progress

4871

REACTION MOTORS, INC.

A MEMBER OF THE OMAR TEAM

DENVILLE, NEW JERSEY

Certificates of Necessity

Washington—Office of Defense Mobilization has awarded The Martin Co., Orlando, Fla., three certificates of necessity totaling $5,039,235 covering the manufacture of guided missiles. All three certificates were allowed 65% of the rapid rate. Other certificates awarded:

Bomac Laboratories, Beverly, Mass., electronic equipment for military use, $675,000 with 50% allowed.

American Welding & Manufacturing Co., Warren, Ohio, military jet engine components, $287,000 with 70% allowed.

Carl Tenk, doing business as Tenk Machine & Tool Co., Cleveland, Ohio, military jet engine parts, $90,105 with 70% allowed.

Goodyear Aircraft Corp., Litchfield Park, Ariz., military aircraft parts, $81,007 with 55% allowed.

CAA Contracts

Washington—Following is a list of contracts as released by the Civil Aeronautics Administration:

I-T-E Circuit Breaker Co., Philadelphia, $264,066 for development of a circular polarization kit for ASR-2 and production of 28 identical kits.

Wilcox Electric Co., Kansas City, Mo., $186,308.08 for transmitting equipment.

Radio Corp. of America, Los Angeles, $106,000 for 20 Air Navigation Development Board Type 2.3NA1B radar beacon transponders and spare parts.

Tower Construction Corp., Sioux City, Iowa, $67,087.50 for guyed towers and erection kits.

Technical Materiel Corp., Mamaroneck, N. Y., $66,525.94 for dual diversity receivers and communications receivers.

Radio Corp. of America, Camden, N. J., $51,636.15 for aircraft interplane control panels.

Triplett Electrical Instrument Co., Bluffton, Ohio, $44,408.48 for volt-ohm-milliameter meters and carrying cases.

George Voron & Co., Philadelphia, $43,-281.02 for VOR antenna spacing templates.

Federal Pacific Electric Co., Cleveland, $41,370.04 for distribution panelboards.

James G. Biddle Co., Philadelphia, $25,-626.47 for insulation testers.

Virginia Electronics Co., Washington, D. C., $18,353.28 for portable battery operated low frequency monitors and spare parts.

Harbishaw Cable and Wire Division, Phelps Dodge Copper Products Corp., New York, N. Y., $14,839.98 for control cable.

The Daven Co., Livingston, N. J., $5,735 for power meters.

Aeronautical Communications Equipment, Inc., Miami, $4,784.70 for a Model AT-144 transmitter, a power unit and antenna tuner.

Maryland Electronics Manufacturing Corp., College Park, Md., $3,375 for modification of an 18 foot beacon antenna assembly.

Eclipse Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., $3,200 for a flight path computer.

Bird Electronic Corp., Cleveland, Ohio, $3,163.50 for wattmeters.

Measurements Corp., Boonton, N. J., $2,-394 for megacycle meters.

Pitometer Log Corp., New York, N. Y., $2,000 for a radar signal simulator.

Ekstein Radio and Television Co., Minneapolis, Minn., $1,014 for three-band mobile receivers.

Hewlett-Packard Co., Palo Alto, Calif., $374,637.17 for VHF/UHF signal generators and associated equipment.

Gonset Div., L. A. Young Spring and Wire Corp., Burbank, Calif., 104,674.12 for

ROCKET POWER PROGRESS REPORT

Igniting Liquid Propellant Rocket Engines

by Leonard Dombras

A research physicist in the Physics Department, Component Development Division, Reaction Motors, Inc., Mr. Dombras has currently been investigating ignition phenomena as applied to rocket engines. A graduate of Rutgers University, where he received a B.S. in Physics, he has been with RMI since 1951.

Rocket engines operate with a wide variety of liquid propellants having various chemical and physical properties. These properties, in conjunction with the application of the missile, dictate the type of ignition system that will be most effective. Although the exact mechanism involved in the ignition process is not completely understood, it is generally believed that, under specific conditions, there exists a minimum threshold energy requirement below which the combustion wave does not propagate. Rocket engine igniters are generally designed to provide this energy on a "more than enough" basis.

Many liquid propellants require no external source of energy to achieve ignition. Hydrogen peroxide, for example, may be catalytically decomposed in the presence of silver or platinum metals, and many bipropellant combinations react spontaneously merely on contact with each other.

Non-spontaneous propellant combinations must be ignited by some form of energy introduced from an exterior source. In early rocket experiments, ignition was achieved with burning kerosene-soaked rags held at the end of a long pole. After several explosive starts, the trend shifted to the use of electrically fired pyrotechnic charges—a technique successfully used in the V-2 and Viking engines and still employed in many single-shot rocket applications. Later ignition techniques employed ultrasonics, catalytic agents, pyrophoric fuels (which react spontaneously in the presence of an oxidizer), electrothermal devices (operating with arcs, sparks, and heated filaments) and torch or flame-type igniters.

The advent of piloted rocket research aircraft required lighter, more compact ignition systems capable of repetitive starts at high altitudes and presented several difficult problems. The experimental X-1, X-1A, and the Douglas Skyrocket, powered with RMI engines, had four thrust chambers which required starting during flight. To insure smooth and positive ignition, torch-type igniters, operating with oxygen and alcohol, were developed. Small quantities of these propellants were injected into a precombustion chamber, ignited, and the resulting flame projected into the rocket motor. This unique device provided high ignition energy, operated at all altitudes, and assured smooth, reliable starts.

Preventing the accumulation of unreacted propellants in the combustion zone is the most important factor in rocket motor starting, regardless of the ignition technique employed. An insignificant ignition delay—in the order of milliseconds—or a sudden propellant surge during the ignition period can result in a buildup of mixtures that may explode with destructive violence.

A successful rocket motor start, therefore, is a function of numerous variables. Propellant flow rates must be accurately controlled and the propellants intimately mixed. The mixture ratio must be ignitable, and the ignition energy must be adequate. These factors are continuously being investigated at RMI for the purpose of advancing rocket science.

Solving some of tomorrow's specific rocket problems—by conducting experiments pertaining to the development or investigation of theories, principles or techniques concerning operation of rocket engines and related equipment—is the general work of the team of specialists comprising RMI's Component Development Division. Our door is open to qualified men interested in this challenging work.

If you desire one or more reprints of Mr. Dombras' article, or would like to receive further information about employment at RMI, write to Information Services, Reaction Motors, Inc., Ford Road, Denville, N.J.

Power for Progress

RMI

CURTISS-WRIGHT

The new CURTISS-WRIGHT *ZEPHYR* JET ENGINE

Air transportation must become quiet not only for its passengers, but for the communities in which it operates. The development of the Curtiss-Wright Zephyr Turbojet was based on the premises: 1 – that its technical excellence must provide a worthwhile performance improvement; 2 – that its advances must be sound in the final analysis from the economic point of view, and; 3 – that it must have a high order of public acceptance, not only from the viewpoint of the passenger, but the communities in which the airport is located and over which the airplane is operated. Moving airports further out of town with its attendant expense and the inconvenience of time lost in additional city to airport transportation is not the answer.

Curtiss-Wright Corporation has completed sufficient testing with the "Zephyr" to warrant the statement that the jet engine transport can be quiet and have a high order of public acceptance.

New Testing Procedure

The testing procedure for the Zephyr is new and novel. Curtiss-Wright discarded the standard jet engine test cell – a mass of concrete, steel, sound absorption, water silencing, etc. – and transferred the testing of the Zephyr to an open air test stand in which the engine is run with no silencing or sound absorption equipment under a specification calling for a minimum of noise, as well as a minimum of fuel consumption, just as the engine would run when it is in an airplane at the airport.

This outdoor testing equipment consists of two mobile vehicles; one on which the engine is mounted for tests; the other housing the control room and instrumentation required to measure thrust, fuel consumption and other equipment. Through the use of these mobile vehicles, the Zephyr is constantly being tested and demonstrated at airports and at off-highway locations to record and analyze its noise levels under idling, taxiing and full throttle conditions. This practical method of testing enables engineers and technicians to change new noise suppressing devices being developed and other equipment quickly and with ease.

The engine may be held at a given set of conditions so that technicians and observers can listen to, record and analyze noise levels for extended periods of time, and, while they are doing this, engine operating conditions can be changed instantly for purposes of demonstration. This method is preferable to listening to an airplane passing overhead where the noise is reduced or muffled, where the time for measuring and recording the volume of noise is limited and where it is difficult to fix the distances and conditions with any degree of accuracy.

Curtiss-Wright plans to demonstrate the mobile testing unit and the Zephyr engine at airports and other locations in the U.S. A request has been received to demonstrate the unit at a major airport in Europe.

Quieter Than Piston Engine

A jet engine transport can be quieter than a piston-engine airplane. For example, Curtiss-Wright has been able to minimize the compressor whine of the jet engine. This is the lesser in decibels of the two principal sources of noise from a jet engine, but, in a practical sense, its frequency and characteristics are something like a siren and more objectionable to some people than the jet noise which is of a lower frequency. Curtiss-Wright has also reduced the jet exhaust noise to acceptable levels because basically the engine is designed so that the mass of air passing through the jet to produce thrust is moving at a lower speed than that common to engines developed for military use at supersonic speeds. For the foreseeable future airlines will fly subsonically, and, therefore, there is no need for using supersonic speed jet engines, with their disadvantages, for jet airline operation.

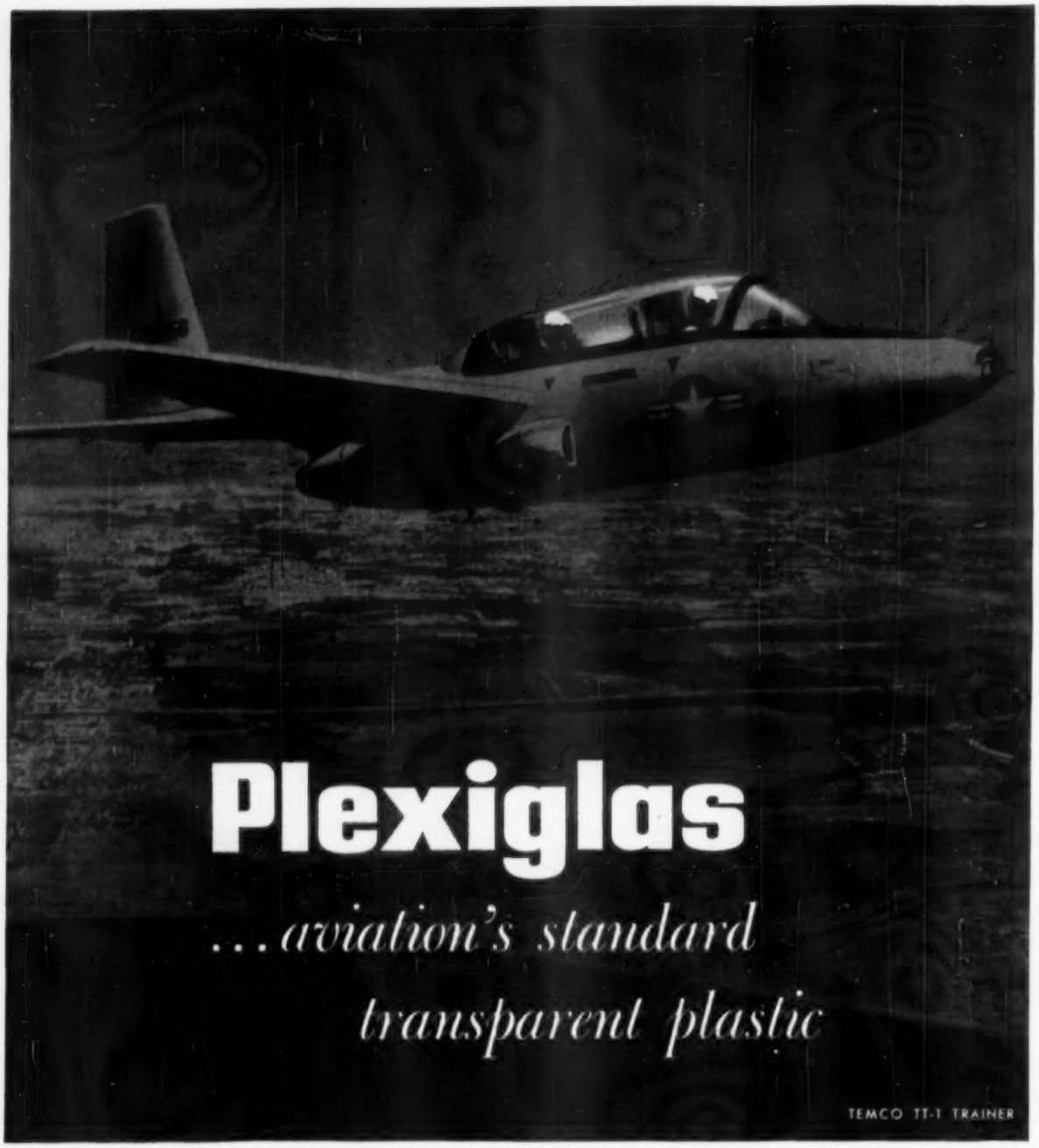
Broad Research Program

Engine noise suppression, while the major element, is only one phase of the Curtiss-Wright program to lower noise levels for aircraft and airport communities. The mobile control room used in the Zephyr tests is lined with Curon, a new sound absorbing, multi-cellular, foamed material developed by Curtiss-Wright. This enables engineers to conduct concurrent tests of new methods of soundproofing aircraft passenger cabins. The same Curon can play an important role in absorbing ground noise at airports where jet and other aircraft are operated. For example, a curtain of Curon hung between runways and buildings will substantially reduce noise at the building. And Curon, in the form of wall tiles, ceiling and floor coverings, can further absorb sound and result in quieter air terminals and offices than ever before.

These are but a few of the technological developments of the Curtiss-Wright Corporation designed to make the introduction of jet airliners to the world airways quieter, more comfortable and economically sound. Others will follow.

This advertisement is published in response to the public interest in the Zephyr Jet engine reflected by numerous inquiries received from individuals and governmental authorities at every level.

CORPORATION **WOOD-RIDGE • NEW JERSEY**



Where there's progress, there's **Plexiglas**

PLEXIGLAS *is a trademark, Reg. U.S. Pat. Off. and in other principal countries in the Western Hemisphere.*

Canadian Distributor: *Crystal Glass & Plastics, Ltd., 130 Queen's Quay East, Toronto, Ontario, Canada.*

Chemicals for Industry

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

Crane for Top Painting

This bosun's chair, slung from an overhead crane, is used by Eastern Air Lines to help its painters re-spray the upper fuselages of its planes passing through overhaul at the airline's Miami base. Tank above the man's head holds paint. Chair has foam rubber cushions and back rest for comfort.

portable transmitter/receiver units and associated equipment.

Allen B. DuMont Laboratories, Inc., Clifton, N. J., $58,408.26 for pulse generators.

Wilcox Electric Co., Inc., Kansas City, Mo., $55,563.55 for assorted transmitting and receiving equipment.

T. M. C. (Canada) Ltd., Ottawa, Canada, $52,624.75, assorted electronics equipment.

Nems-Clarke, Inc., Silver Spring, Md., $33,030.71 for voice-frequency signaling systems and spare parts as a modification of a previous contract.

Western Electric Co., New York, N. Y., $1,225.15 for signaling supply circuits and rectifier power units and spare parts.

Bendix Radio Div., Bendix Aviation Corp., Towson, Md., $586.20 for grid contact assemblies, course tuning plungers, disk insulators and pod assemblies.

AMC Contracts

Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Aircraft Engineering & Maintenance Co., Oakland, Calif., $2,558,124 for IRAN of T-33 aircraft.

Hayes Aircraft Corp., Birmingham, Ala., $2,061,544 for IRAN of C-119 aircraft.

Air-Mod Corp., Chicago, Ill., $3 million for extension of period of performance.

Air-Mod Corp., Cox Municipal Airport, Vandalia, Ohio, $2,632,144 for reconditioning cycle and modification of C-124 aircraft.

Flight Enterprises, Inc., Bradley Field, Windsor Locks, Conn., $2,395,332 for progressive aircraft reconditioning cycle and modification of C-118 aircraft.

Lloyd E. Young & Associates, Inc., 1801 W. Magnolia Blvd., Burbank, Calif., $26,03.) for production of motion picture.

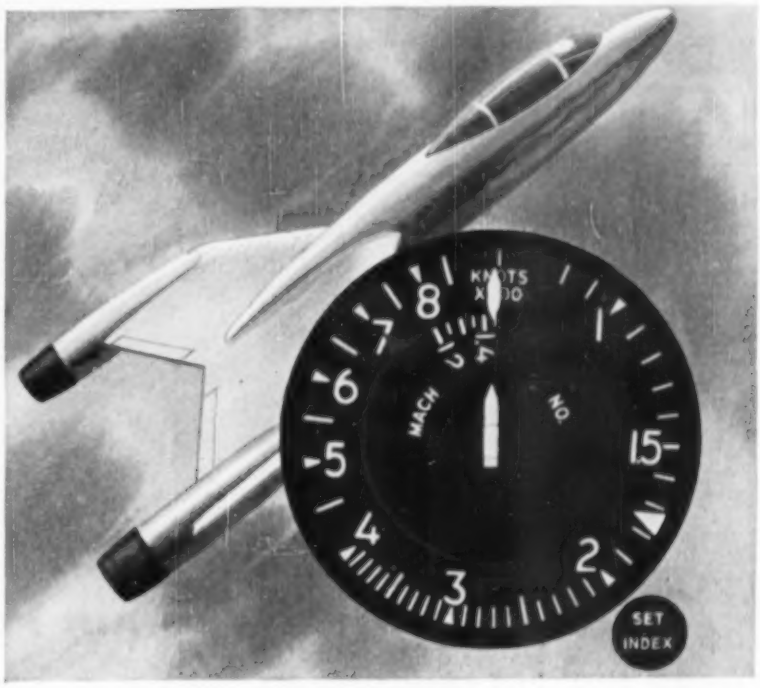
Wilding Picture Productions, Inc., 1345 Argyle St., Chicago 40, Ill., $34,583 for production of motion picture.

Leonard Anderson Associates, Inc., 112 W. 44th St., New York, N. Y., $30,836 for production of motion picture.

Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles, Calif., $29,055 for motion picture release prints for training purposes.

Bruno-New York Industries Corp., 460 W. 34th St., New York 1, N. Y., $504,408 for receiver, R-626-A/ARN-31, spare parts and data.

PIONEERING is our business



BENDIX MACH-AIRSPEED INDICATOR COMPUTES:

$$M = \frac{V_t}{C_s} = \frac{\text{true airspeed}}{\text{speed of sound}} \qquad V_e = V_t \sqrt{\frac{\rho}{\rho_o}}$$

$$V_c = C_s \sqrt{5\left[\left(\frac{\Delta P}{P_o} + 1\right)^{\frac{2}{7}} - 1\right]} \qquad \frac{\Delta P}{P_o} = K\left\{\frac{\left(\frac{V_c}{C_s}\right)^7}{\left[7\left(\frac{V_c}{C_s}\right)^2 - 1\right]^{\frac{5}{7}}}\right\} - 1$$

Bendix Pioneering developed the first instrument to compute both Mach and airspeed—the forerunner of the modern Mach-airspeed indicator.

The present-day Bendix Type 1450 computes and indicates Mach number, equivalent airspeed and subsonic and supersonic calibrated airspeed in knots. Its significant features include:

- Expanded indication at approach and landing speeds.
- Maximum airspeed and Mach limits pre-set for the specific aircraft.
- Mach range from 0.5 to 2.2.
- Airspeed indication from 80 to 850 knots with a landing speed index of 105 to 700 knots.
- Operational range from −1,000′ to 80,000′ pressure altitude.

In today's complete line of high-performance Bendix Mach-Airspeed Indicators, you can be sure there's a model that will serve your individual needs best. You can be sure, too, that all indicators are designed and built to high Bendix standards established in over 35 years' development and manufacture of *better* aircraft instrumentation.

We invite you to bring us your problem and get our recommendations on the most efficient answer. PIONEER-CENTRAL DIVISION, BENDIX AVIATION CORPORATION, DAVENPORT, IOWA.

West Coast Office: 117 E. Providencia, Burbank, Calif.
Export Sales & Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliate: Aviation Electric, Ltd., 200 Laurentien Blvd., Montreal, Que.

Pioneer-Central Division

Bendix
AVIATION CORPORATION

Reeves

salutes

THE UNITED STATES AIR FORCE

upon the occasion of its

golden anniversary

Engineering and production of precision electronic equipment and systems for the UNITED STATES AIR FORCE is the day-in, day-out concern of many hundreds of people and many specialized departments in the Reeves organization. We take personal pride, therefore, in saluting this great Service upon the occasion of its Golden Anniversary.

Among the many significant projects currently being advanced at Reeves for the United States Air Force are the following:

- REAC® Electronic Analog Computers for the largest and most advanced installation of its kind at Wright Air Development Center.
- REAC® Electronic Analog Computer installations at White Sands Proving Grounds, Rome Air Development Center, Edwards, Eglin and Holloman Air Force Bases.
- Reeves MSQ Close Support Control Mobile Radar Systems.
- Reeves Range Instrumentation Radar installations at Patrick AFMTC.
- Reeves Military Radar equipment in a wide range of special types for USAF installations throughout the world.
- Reeves special computer systems for gunfire control and many other applications.

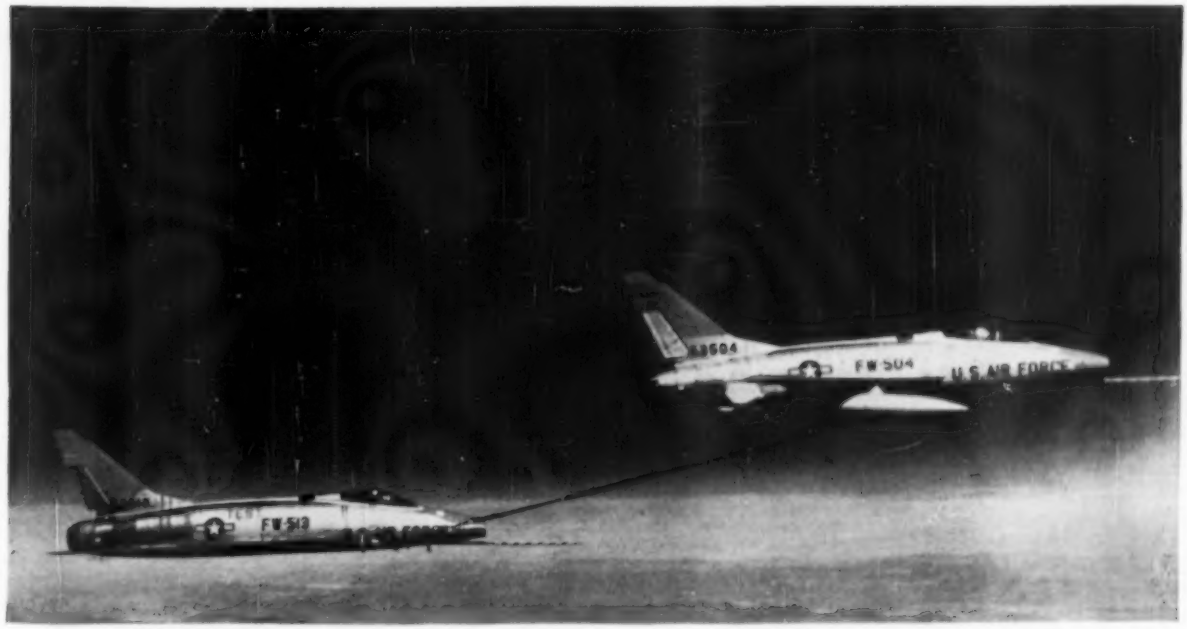
In addition to participation in these USAF projects and manufacture of a wide range of precision electronic components for USAF suppliers, Reeves' research and engineering plays a continuing role in the advancement of vital projects for the other Services.

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

215 East 91st Street, New York 28, N.Y.



SEVEN-LEAGUE BOOTS FOR THE F-100 IN USAF'S GOLDEN ANNIVERSARY YEAR

U. S. AIR FORCE F-100 Super Sabre fighters dramatically demonstrate their newest capability for extending range and load capacity, refueling at their normally higher cruising altitudes and cruising speeds. The "Buddy System" permits one F-100 to refuel another without the necessity of sacrificing altitude or speed in descending to lower level for rendezvous with a conventional tanker airplane.

Development of the F-100 "Buddy System" refueling equipment is an example of the progressive research and development program which Flight Refueling, Inc., has been conducting into all phases of fast fuel transfer problems. F.R.I. designs and produces complete refueling systems for aircraft, both fixed and rotary wing, and is engaged in advanced research projects which are still classified.

If you have a perplexing fuel transfer problem, Flight Refueling's engineers will be pleased to discuss it with you and suggest methods of solving it, either through the design of a system to meet your specifications, or by applying proved F.R.I. design principles to your existing system.

Attention ENGINEERS

Unusual career opportunities for engineering personnel are available in new projects for developing new fuel transfer systems. Write Engineering Manager for details.

Flight Refueling, Inc.

FRIENDSHIP INTERNATIONAL AIRPORT · Baltimore 3, Maryland

REPRESENTATIVES: WEST COAST—*William E. Davis, Box 642, Inglewood, California*
DAYTON—*F. J. Kendall, Box 622, Far Hills Station, Dayton 9, Ohio*

HERBERT W. HINCKLEY, Assistant Chief Engineer, has more than 28 years experience in aeronautics, 24 of them with Convair. He is responsible for directing the activities of the Product Design, Testing, Project and Service Engineering, and Structure Sections at CONVAIR-FORT WORTH.

"Engineers . . . here's how we brought the B-58 from concept to reality in record time!"

"CONVAIR-FORT WORTH was first to develop a modern bomber under the new Weapons System Management concept. This enabled us to save more than two years' time in bringing the supersonic B-58 Hustler from concept to reality.

"As Weapons System Manager, CONVAIR-FORT WORTH cooperated with thousands of other engineers in electronics and related fields. This close working partnership helped greatly to accelerate the design and procurement of every major piece of mechanical and electronic equipment on the B-58.

"We integrated design requirements for this equipment with those of the aircraft, and design of both with the necessary production requirements — materials, tooling, methods and plant facilities. *This carefully controlled, highly integrated program brought the B-58 to the flight test stage in record time.*"

Many of America's most capable engineers, working on the B-58 project, have demonstrated what we mean when we say, "Your future is at CONVAIR-*FORT WORTH*." If you are a qualified engineer with creative talents and vision, we need you NOW! With more than 50 Air Force contracts, we can offer you long-range security and diversity of activity.

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Army Lists Stiff Jeep Requirements

New York—Portions of the Army's aerial jeep specifications are well beyond the current state of aerodynamic and powerplant design, several industry participants commented following award of three contracts as a result of a 21-company design competition (AW Aug. 5, p. 33).

The requirements, which the Army undoubtedly hoped would produce new, more efficient ideas for vertical flight, are stringent in several respects. The aerial jeep is required to:

- **Lift a payload** of 1,000 lb. yet weigh only 1,000 lb.
- **Have a low** downwash velocity.
- **Be small enough** that four vehicles could be flown in a C-130.

To date no rotary wing aircraft has succeeded in lifting a payload equal to its own weight, and it is open to question whether any of the jeep proposals will be able to meet this Army desire. Lifting efficiency of this order will probably be delayed until engines of greater power per pound of engine weight are available.

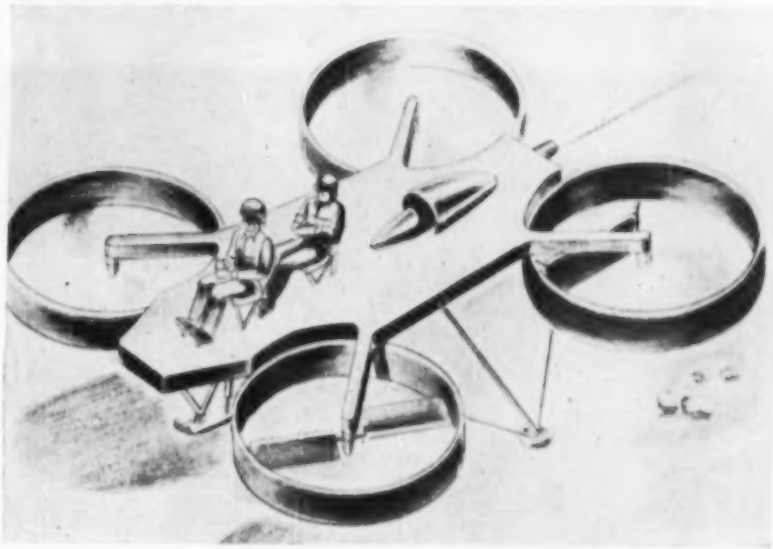
Downwash Problem

Requirement for low downwash velocity is obviously a tough problem as long as lift is provided by directing an air mass at the ground. Downwash in landing in a dry and dusty region would create a dust cloud, aiding the enemy in locating the vehicle and hindering its gun crew.

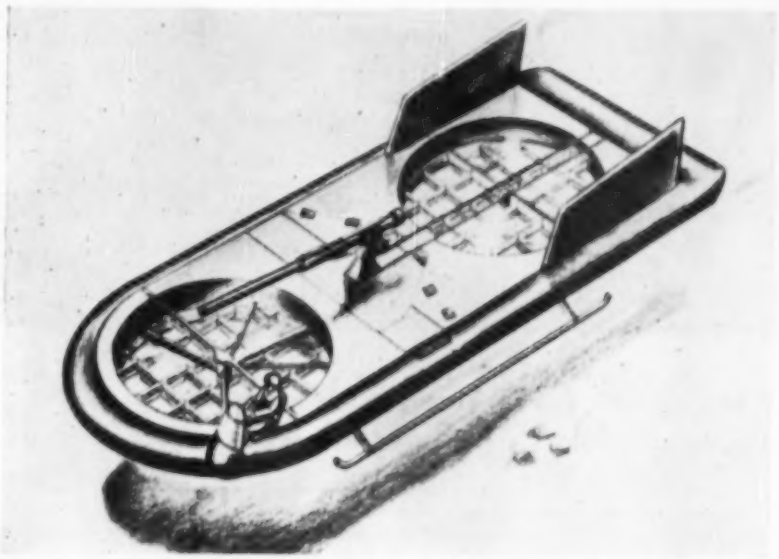
Current requirements are for the jeep to land and then fire its recoiless rifle, rockets, or other armament. After the jeep has completed its development stage and is a proven machine, efforts will probably be made to fire its armament in the air, providing much greater tactical latitude. Most of the weapons planned for the jeep are recoiless and have a heavy backblast covering a wide area. This could be dangerous to the vehicle in the air.

The three winning designs in the jeep competition approach stability and control in three separate ways even though they all use the ducted fan principle. The Piasecki design uses deflector vanes in the air stream while the Chrysler proposal shifts the direction of the complete duct. The Aerophysics design is the only one of the winners to use the inherently more stable arrangement of four ducted fans.

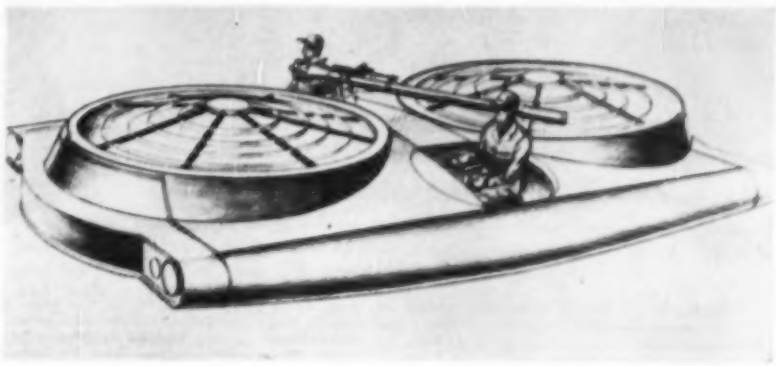
Losing design proposals for the flying jeep are all reported to have used at least two ducted fans except the Fletch-Aire entry described in detail below. One used two intermeshing rotors on each side of a platform with each set enclosed by a figure-eight shaped shroud. Powerplants used varied from



AEROPHYSICS' design uses four ducted fans, inherently more stable than . . .



. . . **TWO DUCTED FAN** systems used in Piasecki design (above), Chrysler (below).



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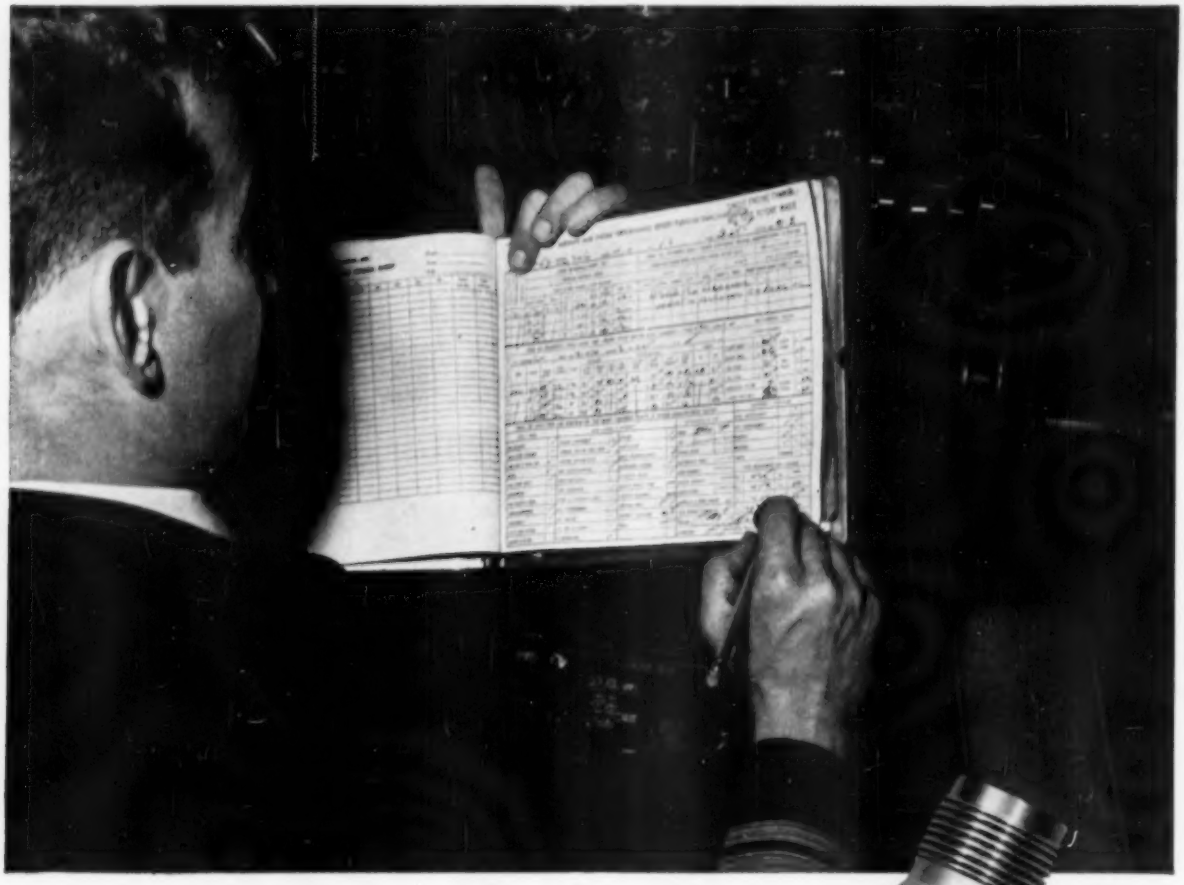

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automobile engines to new light aircraft turbines.

One proposal suggested that a separate contract be let to study kinesthetic control for the jeep. This is the nomenclature that has been applied to the muscular reaction type of control used on small flying platforms. The moment of inertia of the jeep is so large that shifting the pilot's weight would not provide sufficient control moments. To remedy this, the proposal suggested standing the pilot on a platform equipped with power boosts so that he could actuate the jeep controls simply by leaning in the direction he wanted to fly.

The proposal was made in answer to another Army desire that virtually any soldier be able to operate the jeep after a few hours instruction.

One of the unsuccessful contenders for the flying jeep development contract, Fletch-Aire, Inc., Newton, N. J., has decided to go ahead with the construction of its proposal. The tilting-annular wing design is also being discussed with the Office of Naval Research.

Model Studies

Company has done model studies on its design and started fabrication of components for a flying testbed prototype, which should be ready for rollout next summer. Off-the-shelf components are being used to maximum extent to speed assembly at lowest cost and provide reliability.

Tilting wing layout was chosen to permit the cockpit to remain in level position throughout vertical takeoff and conversion to level flight. Circular wing diagonal ducted fan configuration was considerably influenced by National Advisory Committee for Aeronautics reports on their research and published results of work by Helmut von Zborowiski and his coleopter. In addition to performance promised by their tests, Fletch-Aire believes weight of an annular wing can be two-thirds that of a conventional structure.

Fletch-Aire's prototype Flying Jeep would have a wing 10 ft. in diameter with a 56-in. chord, with symmetrical NACA 009-64 section. Projected area would be 58 sq. ft. At a gross weight of 1,500 lb., the single-place prototype craft would be powered by two 115 bhp. horizontally opposed engines. The firm calculates that it would require a minimum of 174 bhp. to hover out of ground effect on one engine. At maximum continuous power, the top speed is estimated at 205 kt., maximum vertical rate of climb at full power at 1,080 fpm.

Wing and the two ducted contra-rotating propellers, which are just shorter than the inside diameter of the wing, are pivoted mechanically about a

Electra Nose Mated, Gear Tested

Assembly of the first Lockheed Electra turboprop has reached the point where the nose section has been mated to the main fuselage structure and installation of the main landing gear has begun. More than 100 drop tests (lower photo) were conducted on the gear with loads up to 125,000 lb. Electra's maximum landing weight is 40,000 lb. Smoke in photo is composed of particles of rubber torn away by impact simulating 170 mph. impact speed. Rate of fall in some tests was 12 fps., Electra's ultimate rate of descent.

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transverse axis coaxial with the pivoting axis of the transmission. Engines are laterally disposed and mounted in the fuselage driving a common transmission which pivots with the wing and propellers. Pivot drive system is linked to the wing by fin support struts. The four symmetrical fins add structural strength within the wing; they are integrated to the lower portion of the propeller shaft on a bearing positioned outside the fuselage contour.

Center of Pressure

As the wing pivots from vertical to horizontal, the aircraft's CG will move from a point slightly ahead of the vertical thrust line to a point along the wing's 18% chord. Fletch-Aire estimates that the annular wing's center of pressure lies between 16%-19% of its chord, depending on angle of attack, and thus balance should be maintained during the transition.

Wing will be pivoted by an electric actuator having a mechanically operated override. Actuator will provide a force to the fin struts near the bearing support, taking advantage of a three-foot moment arm, enabling a 100-lb. force to pivot the wing to horizontal or vertical flight positions. Control switch for pivoting will be on the pilot's control stick.

Conventional stick and rudder pedals will be used, actuating cables passing between wing and fuselage pod on the axis of rotation to minimize control strain during rotation. Rudder and ailerons are mounted on the lower portion of the shrouded fins.

Symmetrical geometry drive system will be capable of operating off a single engine in event of a power failure; the aircraft is designed to hover on one engine, shrouded propellers being more effective than nonshrouded. Fletch-Aire notes that this effectiveness is increased by an order of two to two-and-a-half times, on the basis of NACA studies.

Transmission Support

Transmission will be supported on the engine input ends of the case; a 2:1 gear ratio being used to reduce 3,000 rpm. of the engines. Oil spirals will provide positive lubrication as the transmission is rotated during flight conversion.

Design studies of a four-seater version of the basic configuration powered by either a pair of General Electric T58s or Lycoming T53s have also been made. Engines would be placed below the transmission pivoting axis or mounted laterally and outside the wing in pods to provide more cabin area for crew and payload. However, the latter installation probably would pose lubrication problems while the wing was in the vertical position.

Estimated performance using the T53, based on gross weight of 6,000 lb., is a maximum rate of climb of 1,780 fpm. at full power, top speed of 187 kt., service ceiling of 27,600 ft. and minimum endurance of 30 min. plus 15 min. reserve.

Several armament and reconnaissance systems studies have been made.

- **Two mechanically elevated** rocket pods or 106-mm. recoiless rifles laterally positioned on the annular wing. These could be replaced with camera pods.
- **Single 106-mm. recoiless rifle** on a retractable mount in the fuselage pod.
- **50-cal. machine gun** in a turret capable of firing through 170 deg. could be placed high in the central pod.

PRODUCTION BRIEFING

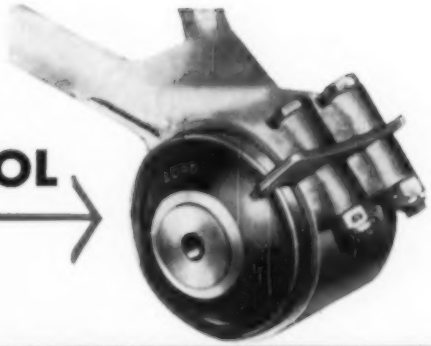
DoAll Co., Des Plaines, Ill., says that its new Model 5 contour machine is the answer to USAF heavy press programs requirement for dies of unprecedented size. In this machine the work remains stationary and the saw is moored in an articulated yoke which can be steered

to follow the direction which the workman guides the cutting blade. Illustrated is the machine's ability to saw a stack of aluminum plates for an air frame part. DoAll says the machine could handle a stack weighing 5,000 lb. or more, making cuts as long as 14¼ ft. over a 70 sq. ft. area.

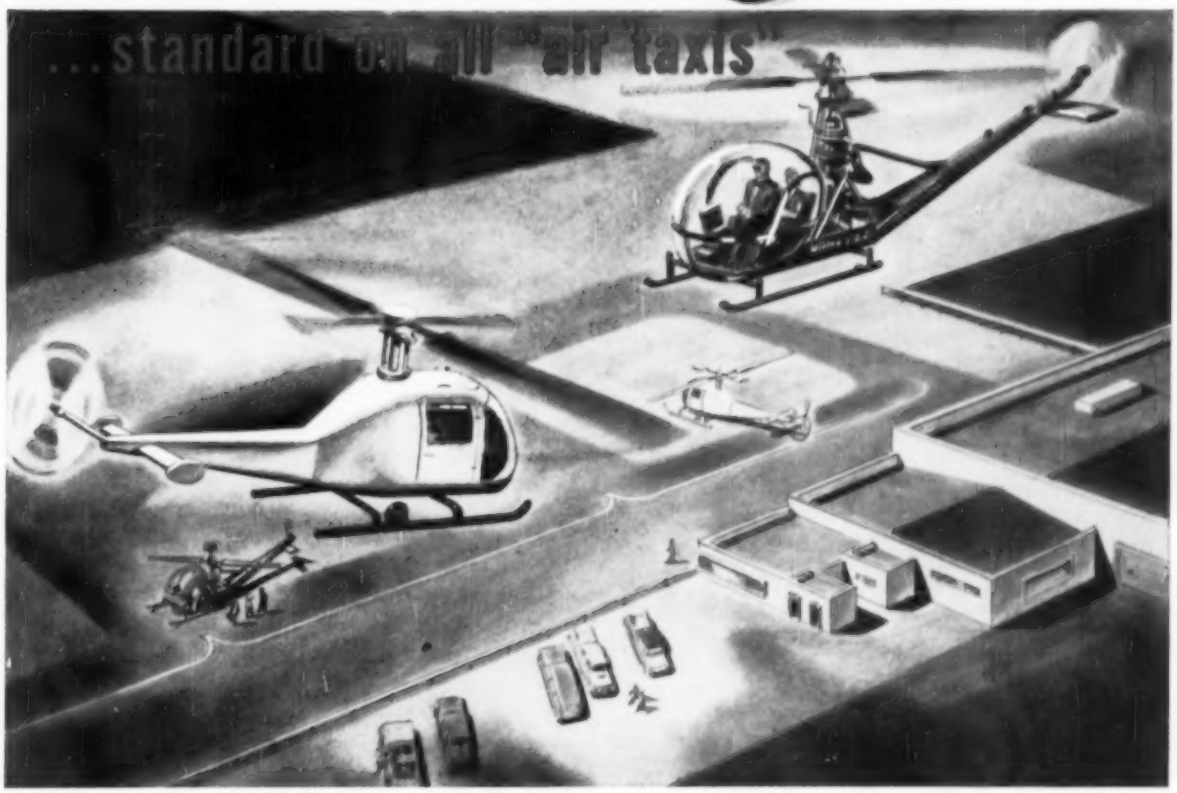
Westinghouse's Aircraft Equipment Dept., Lima, Ohio, in announcing a contract to build the a.c. electrical systems for the B-58 supersonic bomber said that the systems will use circulating oil cooling to overcome the lack of reasonable temperature cooling air in an aircraft flying at supersonic speeds. Three hydraulically driven 40 kva. Westinghouse altenators are in the B-58.

Horkey Associates, acronautical research, engineering, design and development firm, and Moore Development Corp., fabricators of prototype aircraft components and specialists in environmental testing, have merged to provide conception-through-prototype service in components. Headquarters of the firm as well as its shop facilities are located in Torrance, Calif.

LORD
VIBRATION CONTROL
MOUNTINGS



Typical "air taxi" installation of Lord Tube-Form mounting.



"Air taxis"—Bell 47-J (left), Hiller 12-C (right)—answer the growing problem of transporting passengers from city to airport and use Lord Mountings to control vibration.

Lord bonded rubber mountings are standard equipment for controlling the unusual vibration problems on all "air taxi" helicopters. These Lord suspension systems were designed specifically to (1) have built-in strength capable of supporting the entire weight of the craft in flight and (2) provide a resilient coupling for isolating the high frequency engine vibration and the low frequency rotor vibration from the airframe.

Lord mountings flew with the world's first scheduled helicopter service and continue on all ships currently shuttling passengers on commuter-like schedules in and out of more than 20 nation-wide "air taxi" ports. Lord mountings are used for engine, rotor and stabilizer supports as well as torque restrainers.

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Historic Aircraft Bring Profit in Film

Andrews AFB, Md.—What began seven years ago as a bug for collecting historical aircraft turned into a business for Frank Tallman, part of whose $100,000 inventory was flown here for the Air Force Golden Anniversary air show.

A former Columbia Broadcasting System account executive, Tallman was forced to choose between that and his airplanes when he found he hadn't enough time for both.

The result has been his emergence as a competitor of Paul Mantz in the narrowly specialized field of providing and flying authentic aircraft for motion picture and television sequences. Tallman got his first movie job last year in the production of "Lafayette Escadrille," since retitled "With You in My Arms," to emphasize its Hollywood rather than aviation appeal.

Flown in Show

Of Tallman's fleet of aircraft, these were shown at the air show here:

- **Bleriot XI,** purchased from Jean de la Bruyere, French pilot who flew it across the English channel in 1955 to recreate Louis Bleriot's 1910 epic feat.
- **Sopwith Camel,** equipped with a La Rhone rotary engine whose radial bank of cylinders and propellers rotate about a fixed shaft.
- **Nieuport 28,** flown by Tallman in a mock dogfight with a . . .
- **Fokker D.VII,** actually a replica. This is a reworked Travelair 2000 with fuselage lengthened, Ranger engine, dummy cowl and airfoil spreader bar on the landing gear.
- **Fairchild KR-21,** used in a wing walking exhibition.

All but the Camel were flown in the show, the Bleriot in a race with a Curtiss Pusher of the same vintage. Tallman had planned to start the Camel to show the crowd the rotary engine, but show officials balked because of the noise near the stand microphones.

Other Aircraft

Tallman's other aircraft are a Pfalz D.XIII now in buildup stage; a Curtiss-Wright Junior two place pusher monoplane; a Beech Bonanza for business use and two FM-2 fighters.

The FM-2 was a General Motors built version of the Grumman F4F Wildcat which was somewhat lightened and fitted with a Curtiss-Wright engine with more power than the F4F's Pratt & Whitney.

Tallman, a Naval reserve lieutenant

SEQUENCE in movie called for Bleriot to catch fire in air. Pilot set off smoke . . .

. . . **AIRPLANE** was landed, and as pilot fled burst realistically into flames.

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Take-off Distance to clear 50-ft. obstacle at S/L	1,452 ft.	1,540 ft.
Landing Distance to clear 50-ft. obstacle at S/L	1,500 ft.	1,625 ft.
Gross Weight	6,500 lbs.	7,000 lbs.
Useful Load	2,200 lbs.	2,670 lbs.
Range, with 30-minute reserve	1,625 mi.	1,480 mi.
Service Ceiling, 2 engines	22,500 ft.	24,200 ft.
Ceiling, one engine	8,000 ft.	15,000 ft.
Rate of Climb, S/L	1,450 ft/m	1,600 ft/m

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AERO Commander
560-E - 680-S

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commander, keeps and flies these two airplanes mainly for pleasure since their demand for movie work is not great.

Mantz, who has been in the business for years, has 13 known aircraft:

- **Curtiss JN-4 Can.**
- **Two Curtiss JN-4D.**
- **Boeing-built DH-4.**
- **Fokker D.VII.**
- **Nieuport 28.**
- **Eberhardt S.E.5e.**
- **Spad VII.**
- **Four Standard J-1s.**
- **Thomas-Morse S4-C.**

Mantz also has various interwar, World War II and postwar airplanes.

Neither Tallman nor Mantz will make any definitive listing of their fleets because of the competitive aspects. Nor do they trumpet about what airplanes they are looking for because of a potential price skyrocket. Collectors in the business also face competition for historic airplanes from the Air Force, which has sent Mrs. Blanche Scott, an early day aviatrix, on nationwide tours hunting for exhibits for the USAF museum at Wright Field.

Neither of these fleets include what perhaps are the most interesting aircraft to appear in "Lafayette Escadrille"—five Penguins.

Penguin is similar to a Bleriot except that its wings are clipped and it can't fly, at least very far. French used the Penguin to teach pilots to taxi and handle controls. There was no dual instruction. Students just got into their Penguins and started learning by themselves, taxiing around the field and sometimes bouncing the Penguins into the air briefly.

Pilot Director

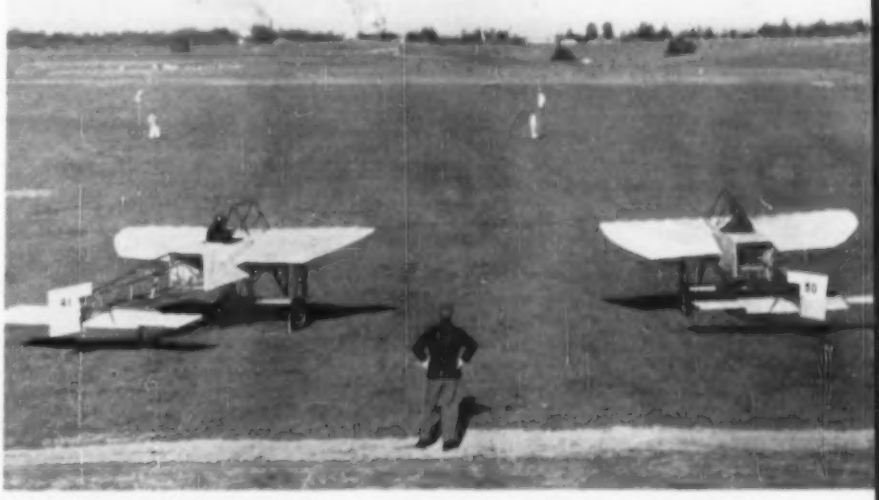
William Wellman, who directed the movie, was a pilot in the Lafayette Escadrille, a World War I French squadron for American volunteers, and his recollections are used for technical authenticity. Tail markings of the Penguins, for one, are those of the French training base at Avord where Wellman learned to fly.

In all rebuilding, as much authenticity as possible is sought consistent with safety rules. Well-known details, such as authentic machine guns, are looked for especially and considerable research is done to produce accurate paint schemes and markings.

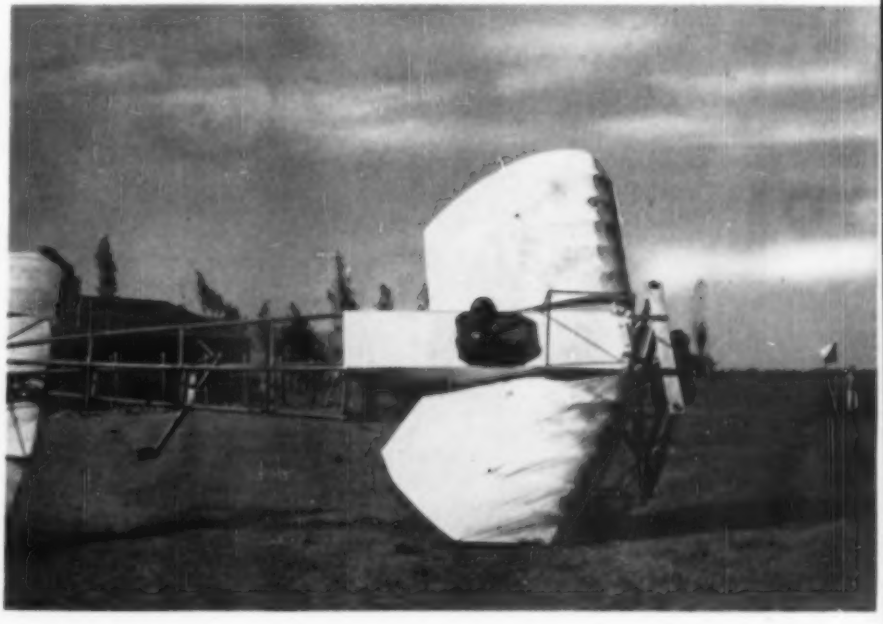
The Penguins were built by Cole Palen, an antique fancier whose barn near Poughkeepsie, N. Y., is full of aircraft artifacts. They were built for Warner Bros., which made the movie, and are stored in one of Warner's warehouses now.

Airplanes flown for movie work were equipped with modern engines, as the Ranger in the Fokker and a Continental in the Nieuport. Penguins used for

NIEUPORT 28 prepares to takeoff with Frank Tallman at controls, brother Foster assisting.



PENGUINS are taxiied by "students" in film. Student ground loop (below) is re-enacted.



VICKERS DEMONSTRATES NEW HYDRAULIC STARTER PACKAGE

As a part of its jet engine hydraulic starting system evaluation program, Vickers Incorporated recently demonstrated the ability of its starter package to start Century Series fighters. Acceleration to ground idle speed of the J-57 turbojet engine, installed in a production North American F-100D Super Sabre, was accomplished in times comparable to other known starting means... using only 50 horsepower, prime mover power.

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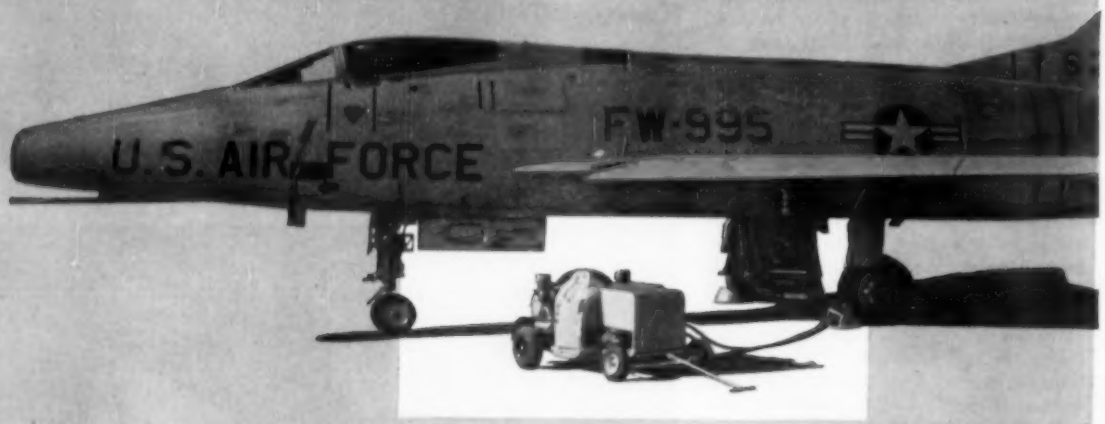
For further information regarding Vickers hydraulic starting systems, write for illustrated brochure SE-94a. Also, your nearest Vickers representative can show you the many system combinations available to meet your specific needs.



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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

static shots in the film had antique scimitar-like propellers, but those used in action sequences had modern Sensenich types.

Reason is that reliability is a must. If hundreds of people—stars, extras, cameramen, etc., all set to shoot—are waiting and an engine won't go, the lid blows off, Tallman said, like nothing he has ever seen.

Stability Problem

Tallman waxes eloquent on the miserable handling qualities of the older airplanes—Penguins and Bleriot. "The Bleriot is a real dog," he said. "It has no control feel at all." Control movements are very exaggerated, and the airplane seems to be always out of control. On hot days Tallman tries to avoid flying it at all.

Nieuport is the best acrobatic ship, Tallman says, being stressed to take 7 Gs inverted. But it has its drawbacks. Tallman flew it cross country to promote the air show, and inside the cockpit near the floor the temperature averaged around 120-130 deg. The rudder pedals are located close to the engine firewall.

Tallman and two other pilots flew 100 hr. in the course of filming the movie. Flight sequences were done at Santa Maria, Calif. Filming included a fire scene in a Bleriot using chemical smoke set off by the pilot from a cylinder in the cockpit and the deliberate ground looping of a Penguin. Pilots worked from ground level up to altitude of 4,000 ft., and one scene included a night landing on a flare lit field.

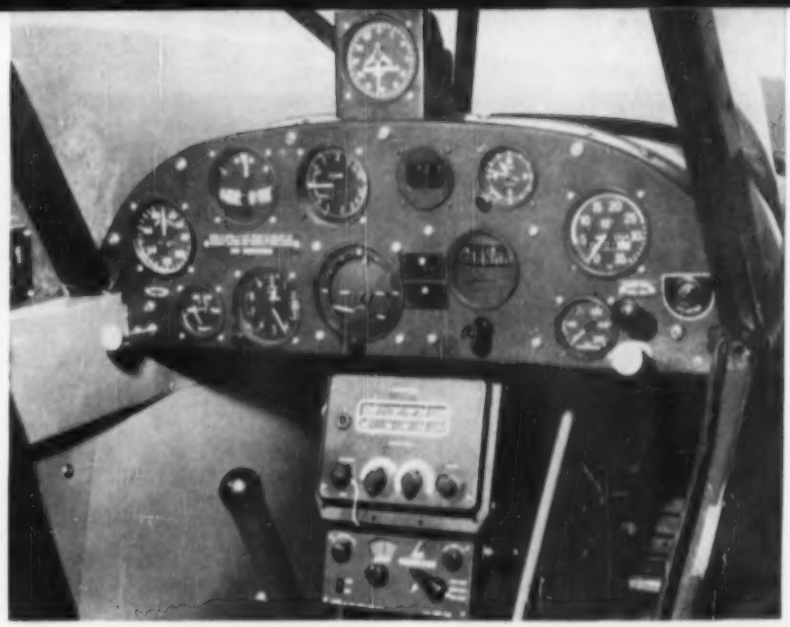
Tallman used the Curtiss-Wright Junior for air-to-air work. Its slow speed and maneuverability and location of the front cockpit well ahead of the wing with good visibility made it well suited for this kind of assignment.

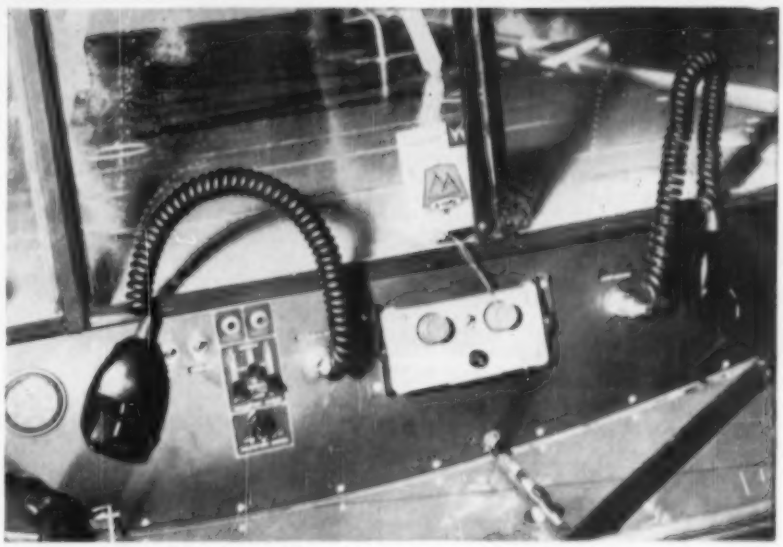
The airplanes are hangared now at Riverside, Calif., and Tallman is in process of moving to the West Coast from his former home in Chicago. His pilots also are mechanics, to cut overhead. On occasion he uses veteran fixed base service people experienced in handling old airplanes for major maintenance.

Tallman found the business took a long time to break into, but besides the movie job a year ago he has done three air shows this year. Business looks good, he said.

AMC Lets Contracts For Flight Training

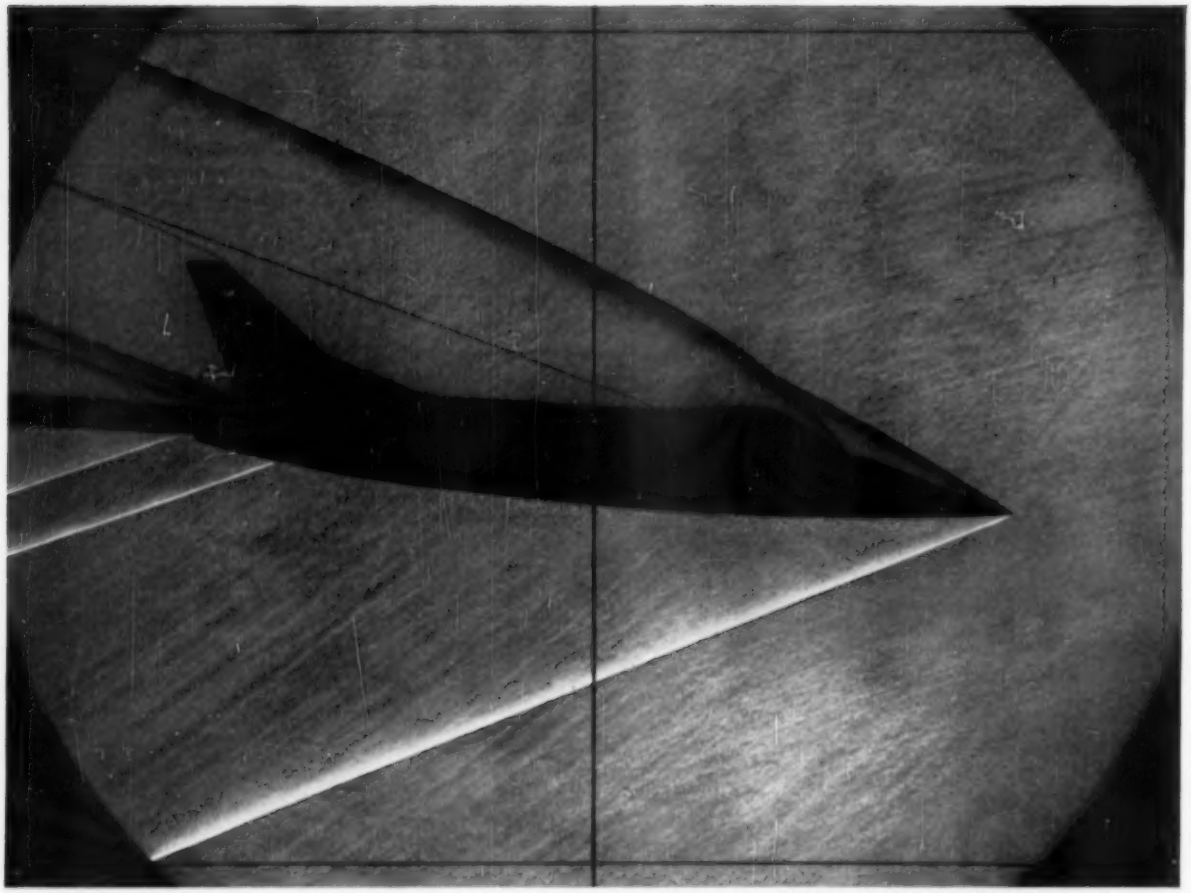
Wright-Patterson AFB, Ohio—Air Materiel Command has awarded the following companies and flight schools $1 million letter contracts each for the operation and maintenance of primary





Super Equipped Super Cub

One of the most completely equipped Piper Super Cubs built is this one used by Department of the Interior's Immigration and Naturalization Service to patrol U.S.-Mexican border against illegal immigrants. Top view shows full complement of gyro instruments, radio and navigation instruments including artificial horizon, Jack & Heintz directional gyro, Lear ADF-12D (indicator atop panel) and Narco Mk. 2 VHF transmitter/LF receiver. On upper left side of cockpit are two complete communications systems in addition to standard radio: one system allowing contact with I&NS departments and the other for a public address loudspeaker service so crew can talk directly to ground. Bottom photo of Department's Super Cub shows faired-in loudspeaker vents on lower fuselage.



Schlieren photograph of supersonic flight patterns in wind tunnel.

There is a formula for supersonic supremacy

Supersonic supremacy is the absolute condition of America's future security. It is a day-to-day thing. It must grow with major new advances; it must be strengthened by aircraft that fly much faster, much farther and higher.

North American Aviation's vast backlog of experience in the design and production of supersonic aircraft—by far the greatest in the Free World—is concentrated on this unending challenge. There are sound reasons for North American's ability to design superior aircraft with certainty—and to turn them into hardware with speed and economy:

North American designs for performance. The supersonic F-100 Super Sabre exceeded the speed of sound on its first flight in 1953. And there is still no Air Force operational airplane that can match the F-100's tactical and combat versatility, or its endurance—proved by record-breaking non-stops: London to Los Angeles, Los Angeles to New York, and New York to Paris.

North American designs for production. From the beginning, North American's engineers have designed every airplane for rapid, low-cost production. That is why North American can turn a new weapons system concept into a flying reality in the shortest possible time.

North American designs for growing potential. From the basic F-100 design came a brilliant series of new versions—the F-100A, C, D, and F—all adapted to special duties without sacrificing speed, range, altitude, or payload ... or spending the years and millions normally required for new designs.

North American designs for the future. The X-15 rocket plane, now in production, will carry man higher and faster than ever before. Other major supersonic projects now in advanced development include a long-range interceptor for the Air Force at North American's Los Angeles Division and the A3J, a carrier-based attack weapon system for the Navy, at the Columbus Division.

The formula for supersonic supremacy in the future is supersonic experience today. North American has it.

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pilot training schools, with definite contracts estimated at $3.2 million each:

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Garner Aviation Service Corp., Bartow Air Base, Bartow, Fla.

Pittsburgh Institute of Aeronautics, Graham Air Base, Marianna, Fla.

Texas Aviation Industries, Inc., Hondo Air Base, Hondo, Tex.

Anderson Air Activities, Malden Air Base, Malden, Mo.

Hawthorne School of Aeronautics, Spence Air Base, Moultrie, Ga.

California-Eastern Aviation, Inc., Moore Air Base, Mission, Tex.

PRIVATE LINES

Earnings of $350,362 after taxes on sales of $3.9 million are reported for 1956 by Spartan Air Services, Ltd., Ottawa, Ont., aerial survey firm. During first quarter of 1957, contracts totaling $3.8 million were received, up 40% over same period in 1956.

Aerial applicator handbook, consisting of information offered during agricultural aviation conferences conducted in Texas under leadership of Prof. Fred Weick, is now available for $2.50 from Short-Course Office, Agricultural and Mechanical College of Texas, College Station.

Ten jet engines for instruction purposes have been purchased by Academy of Aeronautics, LaGuardia Airport, N. Y., and the school plans to increase lecture and laboratory instruction on turbine powerplants nearly 150%. Instruction jets include J47, J35, J34, J33 and J30.

More than 208 million gallons of aviation gasoline were pumped into private and commercial aircraft in New York State between Apr. 1, 1956-Mar. 31, 1957, N. Y. Dept. of Taxation & Finance reports. Airlines used 186,099,706 gal.

"Fly-in" dude ranch and other sports and recreation activities will be featured in proposed development of former Riddle Field, Fla., onetime 2,600-acre British flying training installation. Development by Air Glades, Inc., is being sponsored by Gene W. Goble, C. O. Moody and Vernon Stewart, Miami.

Ability to maintain straight and level flight under simulated instrument conditions, perform medium turns to predetermined headings and climb and descend straight ahead is new requirement for membership in Flying Physicians Assn. to stimulate advanced training and as safety measure when pilots suddenly find themselves in bad weather. FPA now has over 800 licensed pilot members in U.S.

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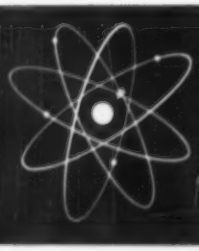

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DOUGLAS AIRCRAFT, INC., Long Beach, Calif., reports: ". . . The Livermont Limiter was subjected to every type of application in aircraft assembly, with very satisfactory results, to determine its potentiality. As a result, this Long Beach plant is converting 100% all air-powered screwdrivers. We have not had to repair or recalibrate a Livermont Limiter even though some have been in service for over a year running three shifts a day."

At Douglas, Livermont Limiters powered by Ingersoll-Rand air motors combine the speed of air powered tools with the accuracy of manually operated torque wrenches. Proven to be much faster than old methods, the Limiter maintains indefinitely, a positive accurate torque from 5 to 85 inch pounds without impacting or ratcheting.

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NAVY:	"Tested and evaluated, U. S. NAVAL AIR STATION, San Diego, Calif."
LOCKHEED:	". . . 1 man does the work of 5 . . ."
AIR FORCE:	"Tested and evaluated at WRIGHT AIR DEVELOPMENT CENTER, Ohio."
RYAN:	". . . proved to be 10 times faster than former methods."
CONVAIR:	". . . reduces bit breakage from 100 per day to 10 in seven weeks."

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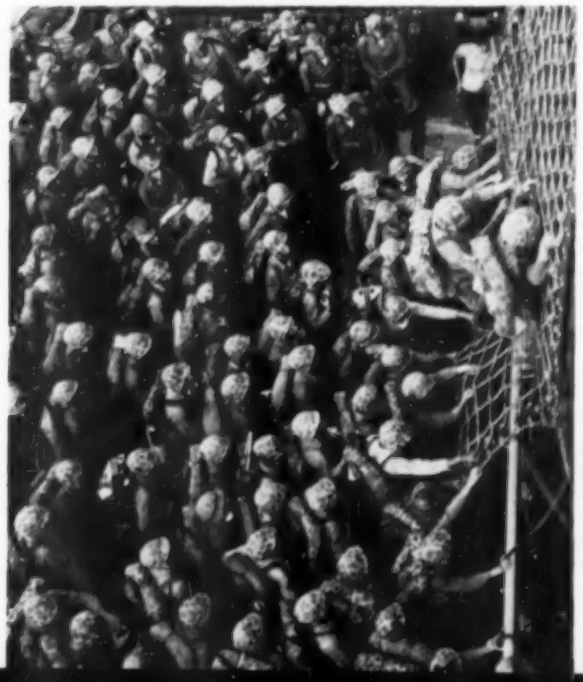
MARINE HUS (Sikorsky S-58) takes off from the carrier Leyte during exercise. Helicopter was from Marine Air Group 26.

Helicopters Land Marines in Panama Invasion Exercise

Marine Corps troops use helicopters based on the USS Leyte (left and above) to land in a simulated attack on Gatun Dam in the Panama Canal Zone. Troops are boarding the carrier (below, left) and landing ashore (below, right).

LEYTE, which mounted assault from Vieques Island, Puerto Rico, carried S-58s and also Sikorsky HO4s (S-55) helicopters.



Don Walter, B.S. M.S., achieved an outstanding academic record at Cal Tech, Class of '40, while earning seven varsity letters. Today as Vice President in charge of Engineering and Van Nuys Operations, Don utilizes his technical and teamwork background to lead Marquardt's engineering and development manufacturing. He is an example and exponent of Marquardt's management philosophy.

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CAB Accident Investigation Report:

Pilot Flew Into Darkness, Weather Despite IFR Ban

Alaska Airlines Flight 701, a Stinson AT-19, N 79069, crashed during a snowstorm near Nome, Alaska, at approximately 1825 Bst.,[1] Oct. 2, 1956. All five occupants were killed and the aircraft was demolished.

HISTORY OF THE FLIGHT

Alaska Airlines Flight 701 is a scheduled operation between Unalakleet and Nome with intermediate Alaskan stops at Shaktoolik, Haycock, Moses Point, Golovin, White Mountain, and Council. The operation is restricted to day visual flight rule conditions and the company principally utilizes single-engine Stinson AT-19 aircraft.

On Oct. 2, 1956, Flight 701, piloted by John D. Hutchinson, departed Unalakleet at 1321. The VFR flight plan estimated a cruising true airspeed of 90 mph. and showed there were 74 gal. of fuel aboard, enough for about 4 hr., 30 min. The flight was routine to Council. When takeoff was made at Council the flight time was 2 hr., 25 min. and the elapsed time (including ground time at Council and other intermediate stops) was 4 hr., 24 min.

Flight 701 departed Council with four passengers at 1745 on the last leg of the operation to Nome. The estimated flying time to Nome was 40 min. and the departure time of the flight indicated that it would not be completed before the end of civil twilight, which was of approximately 48 min. duration, beginning at 1727. The aircraft was observed after takeoff taking up a southwesterly heading toward the coastline route over low terrain to Nome.

At 2023 Flight 701 was overdue and unreported. When it could not be contacted search procedures were initiated.

INVESTIGATION

At 1500 on Oct. 3, 1956, the wreckage of N 79069 was located on Cape Nome, at a point about 15 mi. east-southeast of Nome.

Initial impact was on level ground at an altitude of 25 ft. msl. at the eastern base of a 650-ft. ridge of high ground running north and south.

The southern end of this ridge is three-tenths of a mile north of the shoreline to which it descends in a steep slope. This ridge lies across the flight path between the point of impact and Nome. The point of impact is within the intersection of airways Amber 1 and Green 7.

Examination of the terrain disclosed no trace of impact by the plane against the higher ground of the ridge. The wreckage itself showed that it had struck the ground at a downward angle of more than 45 deg. while heading approximately 157 deg. true. The bearing from this point toward Nome is 284 deg. true.

Impact occurred while the left wing was low. A gouge in the ground 12 ft. long at right angles to the centerline of the fuselage ended at the left wing. This wing, the nose, and the landing gear which had separated, had absorbed most of the impact forces.

The left wing remained attached to the fuselage by the aileron cables only, the structural attachments having failed in an upward and rearward direction. The aileron, although severely damaged, remained attached to the left wing as did the flap. The left wing tip was demolished by forces which included dragging contact with the ground. The leading edge of the wing was flattened along its length into a plane almost normal to its chordline.

Fabric Condition

With the exception of impact damage, the fabric covering of both right and left wings, ailerons, and flaps was found in good condition with no evidence of tearing or fraying prior to impact.

Both fuel tanks, located in the wing butts, were severely buckled and ruptured by impact. Stains on the ground and on the structure immediately adjacent to the ruptured fuel tanks indicated that considerable fuel spillage had occurred.

The attachment of the right wing and of its aileron and flap was distorted but unbroken. Flaps were in the retracted position with controls still connected.

The powerplant was completely imbedded in the frozen ground. Gouges in the earth showed that the propeller was rotating at high rpm. at impact.

The elevator tab was set slightly to trim the nose downward.

Because of severe impact damage the only cockpit control positions that could be determined were: Fuel tank selector on Right Tank, ignition switch On Both, radio receiver set at 250 kc. Equipment included a complete set of blind flight instruments with artificial horizon, directional gyro, and bank and turn indicator, all operated from an engine-driven vacuum pump.

All components of the aircraft were accounted for in the wreckage and there was no evidence found to indicate fire, structural failure, or malfunction of equipment in flight.

A check of the weights of the aircraft, crew, passengers, fuel, and cargo on board gave the computed gross weight at takeoff from Council as 4,163 lb., 167 lb. below maximum allowable. The weight distribution was within allowable limits.

The U. S. Weather Bureau forecast for the period 1400, Oct. 2, 1956, to 0200, Oct. 3, 1956, was available to the pilot before his takeoff from Nome eastbound and

[1] All times herein are based on the 24-hour clock and are Bering standard.

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before his takeoff from Unalakleet westbound (returning to Nome) at 1321. The forecast for the southern Seward Peninsula (which included the scene of the accident), the remainder of the Koyukuk Valley, and the middle Yukon Valley west of Ruby, was: ceiling 3,000 and scattered to broken clouds.

On Oct. 15, 1956, an aftercast was made by the U. S. Weather Bureau Airport Station at Anchorage, Alaska. This aftercast is quoted below:

"AFTERCAST OF WEATHER CONDITIONS IN THE VICINITY OF CAPE NOME, ALASKA, DURING THE AFTERNOON AND EARLY EVENING OF OCTOBER 2, 1956

"The weather maps for October 021830Z, 030030Z, and 030630Z showed an elongated trough of low pressure oriented north-south along a line from Bettles to Anchorage, with a complex low pressure system to the southeast of Kodiak Island. While the trough was moving slowly eastward during the day, a cold front that had passed over the Seward Peninsula the night before was moving southward over southwestern Alaska in the strong northerly flow behind the trough. By evening the front had passed to the south of Bristol Bay.

"The air mass in the vicinity of Cape Nome was cold and unstable, and there was scattered snow shower activity in the area. A study of available evidence indicates that there were broken to scattered clouds with bases at 3500 to 4000 ft., msl. tops generally 6000 ft., but with occasional cumulus build-up to 10,000 ft. The weather at the scene of the accident could have ranged from the above described condition to as low as 500 ft. obscured, one half mile visibility, in moderate snow showers. The surface winds were very likely from the northwest at about 15 mph., but could have been as strong as 25 mph. The freezing level was at the surface, and light icing could have occurred in the clouds. Some low level turbulence undoubtedly existed; this would have resulted from the unstable air mass and the fairly strong low level winds."

On Oct. 2, 1956, atmospheric conditions made radio communication difficult, and no message was received from N 79069 although it was equipped with two-way radio.

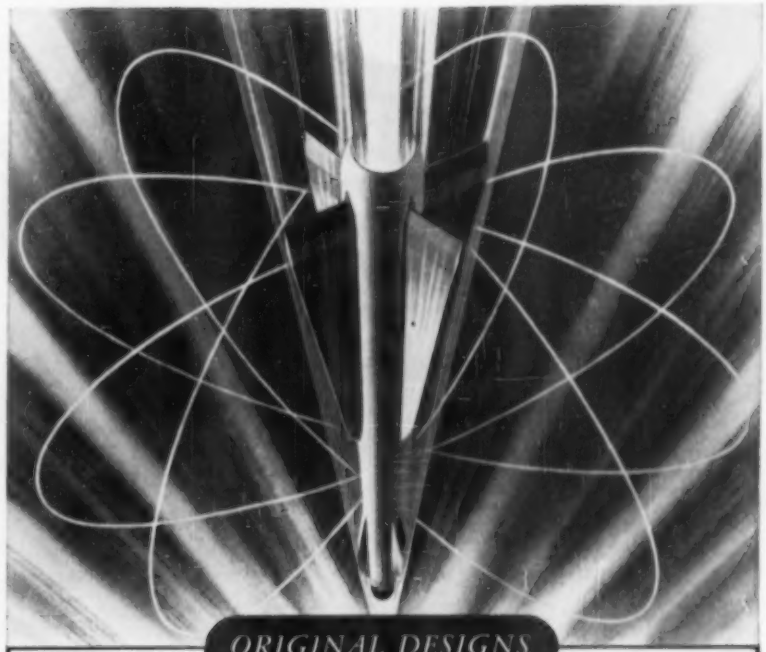
A professional aircraft pilot was driving in the area of the accident about 1745 on the day of the accident. He reports that he: ". . . noticed a snow shower moving toward us from the northwest. I believe the ceiling and visibility would have been below minimums even if it hadn't been getting dark at the time.

Search Begins

"The next morning, Oct. 3, I left Nome in a Piper Apache looking for the lost plane. I went directly to Council and talked with a partner of one of the passengers (a Mr. Anderson, who is with Northern Mining Company).

He said that the flight left Council at 1745 and headed in 'a southwesterly direction'."

The pilot had logged proposed details of this flight as a (day) VFR flight plan. He was not certificated to fly under instrument flight rules, nor was the company authorized to conduct instrument flight over this route



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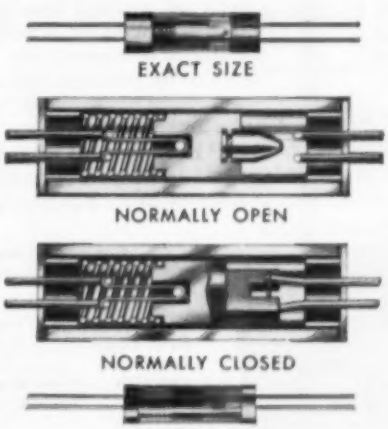

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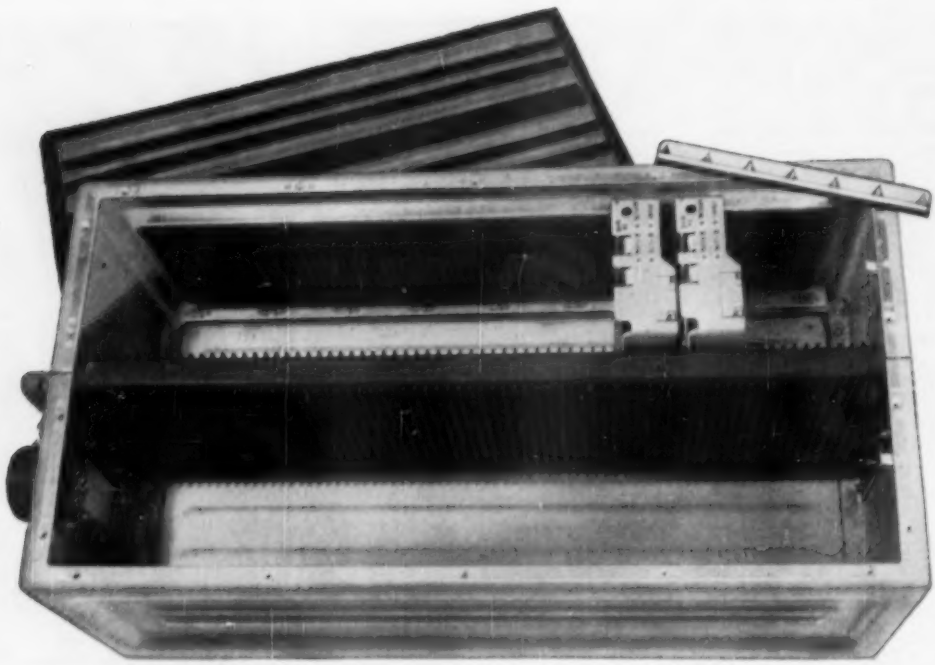
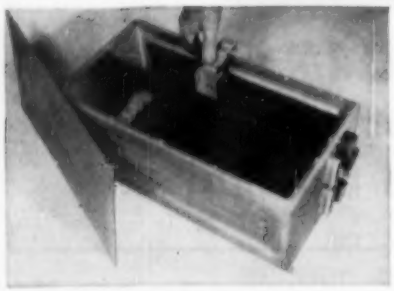
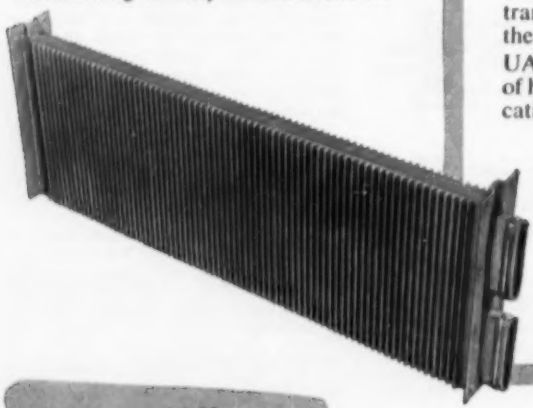




Precision control of groove depth and spacing assures ease of servicing and interchangeablility of circuit shells.



Printed Circuit Heat Control

Here is how one airframe manufacturer integrated printed circuit design with "black box" design.

A UAP cold-plate heat exchanger forms the central member of the assembly. Grooves machined into the heavy face plates of the cold-plate, match grooves in the two compounded plates which line the longer inner walls of the box. Printed circuit shells are inserted into the grooves in two banks, either at random spacing or closely packed with an assured minimum clearance between shells. Electrical contact is made with the circuits by pressure only. Heat from the printed circuits is transmitted to the aluminum UAP cold plate and conducted to the ultimate heat sink.

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with light aircraft. Also, as far as can be learned, Hutchinson had had no training or experience with instrument flight.

ANALYSIS

From Council to Nome along the coast is 74 mi., or 17 mi. longer than the direct route.

At the planned true cruising airspeed of 90 mph. it would require 11 min. more than the direct route. The coastal route could be flown at near sea level whereas the 11-min.-shorter direct route passed over rugged terrain.

Also, the coastal route offered an occasional ground light.

When the flight departed Council at 1745 the weather there, and reported weather ahead, was above VFR minimums. Sunset at Council on that date was at 1719; at Nome it was at 1726. Official civil twilight on that date and for that area lasted from 1727 to 1815. The operations specifications of the air carrier restricted its operation over this route to day only. By definition "day" ends at the end of civil twilight. There was an overcast in the crash area and it is probable that total darkness existed at the time of the crash. This condition is confirmed by a qualified witness who was in the area of the crash at 1745.

Restriction Basis

The restriction against night or IFR operations contained in the air carrier's operations specifications is provided in order to prevent the type of situation which occurred in this instance. The judgment of the pilot in planning and executing a flight under these circumstances is open to serious question.

Having departed Council for Nome so short a time before sunset, he was committed to complete the flight at Nome since the lack of lighting facilities at Council made it impossible to return to his point of departure and no other suitable airports were available along the route for use as alternates.

It appears that the pilot, aware of the failing light, flew directly to the coastline and then proceeded westward along it toward Nome. He may well have seen no evidence of snow showers approaching from the northwest because of the overcast and failing light.

As the flight, now in near total darkness, approached Cape Nome snow showers may have been encountered which further reduced visibility. However, the flight continued with the pilot probably attempting to fly contact by reference to the road or coastline.

It appears likely that Hutchinson was not completely sure of his position when he reached a point near the scene of the accident.

It is believed that at this time he completely lost visual contact, and without instrument training, lost control and struck the ground in a steep spiral.

It is also possible that he had a fleeting glimpse of the ridge while at low altitude and in attempting to avoid it lost control of the aircraft.

Since the only icing conditions mentioned in the aftercast were ". . . and light icing could have occurred in the clouds" and since the flight was limited to day VFR

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Nine of the 14 Lockheed aircraft in or approaching flight test: Front row—F-104A fighter, T2V-1 trainer, F-104B two seat fighter-trainer; second row—1649 Starliner commercial transport, W2V-1 radar search plane, 1049 Super Constellation; back row—P2V-7 patrol bomber, Electra prop-jet transport, WV-2 radar search plane.

A fleet of Lockheeds for flight test engineers

Big assignment for flight test engineers and analysts: Test-prove a fleet of Lockheeds year after year.

The planes change, but there is always a varied fleet of aircraft demanding the ingenuity of Lockheed's Flight Test Engineering Staff. In such a diversified program engineers flight-test cargo and passenger prop-jet transports; jet fighters, trainers and interceptors; turbo-jet transports; bombers; radar search planes and unique aircraft such as the U-2 high altitude test plane.

The aircraft flying above represent an important share of Lockheed's current flight test program. At present 12 different models—an average of 30 planes—are in flight test. And coming soon—the important prop-jet Electra and 10 passenger turbo-jet transport projects.

Architect's drawing of Lockheed's new Burbank flight test engineering and experimental center. It will augment extensive flight test facilities now in operation at Burbank and Palmdale, California. It is scheduled for occupancy September, 1957.

This program of unmatched diversification has created a number of new positions on all levels for professional flight test engineers and analysts and instrumentation engineers. The brief résumé form below is for your convenience in contacting E. W. Des Lauriers, manager of Lockheed's Placement Staff.

E. W. Des Lauriers, Manager, Placement Staff, Dept. 03083

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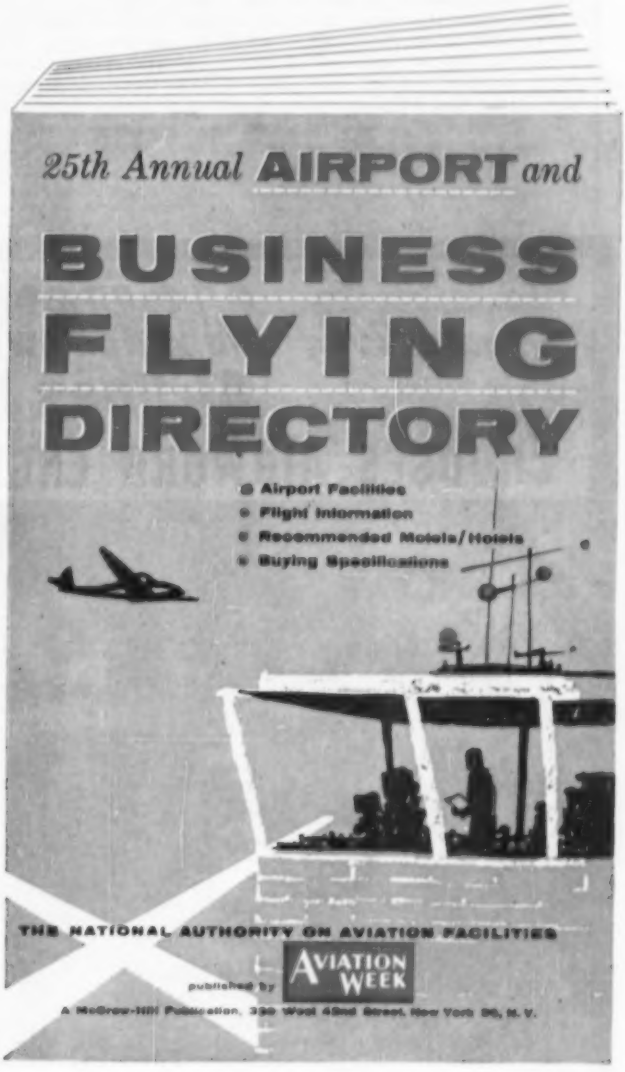

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AW1

conditions, it seems improbable that the icing conditions could have contributed to this accident.

On the basis of all available evidence the Board finds that:

1. Carrier, aircraft, and pilot were properly certificated for day VFR operations over the route involved.

2. Gross weight and its distribution were within authorized limits.

3. Flight was routine to Council.

4. The area forecast indicated weather conditions between Council and Nome would be better then VFR.

5. The official civil twilight for Nome on October 2 was between 1727 and 1815. The flight departed Council at 1745 and crashed at approximately 1825.

6. En route, Flight 701 lost visual reference with the ground.

7. The pilot, inexperienced in instrument flying, lost control of the aircraft and crashed.

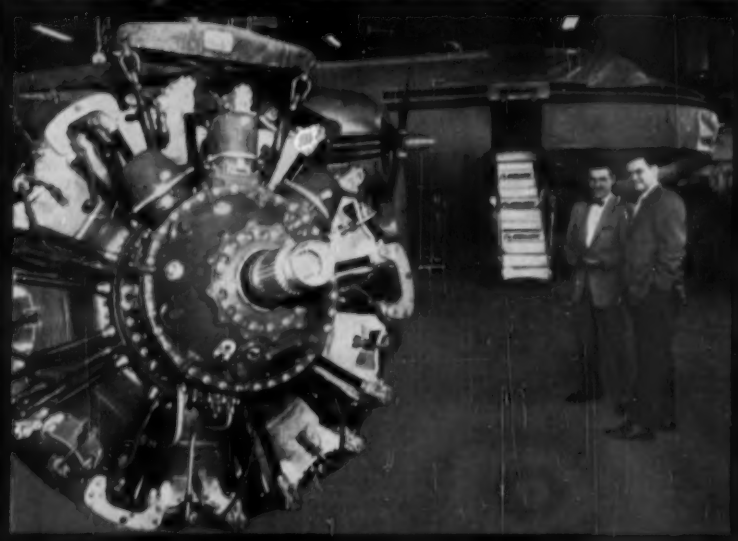
PROBABLE CAUSE

The Board determines that the probable cause of this accident was the action of the pilot in flying into conditions of darkness and adverse weather in which he could not maintain adequate control of the aircraft.

By the Civil Aeronautics Board:

/s/ James R. Durfee
/s/ Chan Gurney
/s/ Harmar D. Denny
/s/ G. Joseph Minetti
/s/ Louis J. Hector

Here's Why MOHAWK Airlines Inc. CHOOSES AIRWORK ENGINES



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GLENN IRISH, Purchasing

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Airwork CORPORATION Millville, New Jersey

SUPPLEMENTAL DATA

The Civil Aeronautics Board's Anchorage, Alaska, office was notified about 2030 on Oct. 2, 1956, that the aircraft was missing. The wreckage was found about 1500 Oct. 3, 1956. Investigation was started immediately in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended.

Alaska Airlines, Inc., is a scheduled air carrier. It holds Civil Aeronautics Administration operating certificates and Civil Aeronautics Board certificates of convenience and necessity which authorize it to operate both main line and feeder line services. The operation involved in this accident is a feeder line authorized by permanent certificate of convenience and necessity (No. 128) and by an air carrier operating certificate issued by the Civil Aeronautics Administration pursuant to Part 42 of the Civil Air Regulations.

On this feeder line the carrier is authorized to operate light planes under day VFR conditions only and no clearance from dispatchers is required.

FLIGHT PERSONNEL

Pilot John D. Hutchinson, age 25, was employed by Alaska Airlines as a bush pilot on Jan. 25, 1956. He was based at Nome, Alaska, during his entire employment. He held a valid airman certificate with commercial pilot and single-engine land ratings. Company records indicate that he had flown 5,000 plus hours, all in single-engine aircraft, in various parts of the United States and Alaska. While employed by Alaska Airlines he flew 492 hr. out of Nome in Stinson AT-19 and Norseman UC-64 aircraft. Most of that time was over the route involved. His last route check was dated July 27, 1956. His last physical, second-class, was successfully passed on Nov. 15, 1955, without waivers or limitations.

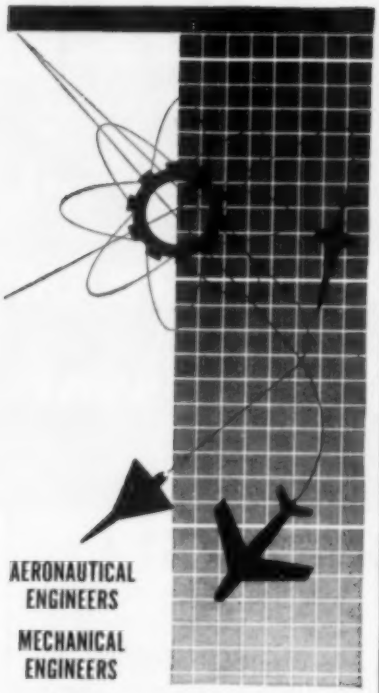
THE AIRCRAFT

N 79069, Stinson AT-19, manufacturer's serial No. FK 975, had been flown a total of 2,484 hr., 336 hr. of which were subsequent to its last annual inspection, 44 hr. since its last 100-hr. inspection, and 5 hr. 40 min. since its last line maintenance. The powerplant, Lycoming R68013, manufacturer's serial No. 12676, was equipped with a Hamilton Standard 2B20 propeller, manufacturer's serial No. T14399. The powerplant and propeller had each been operated 98:45 hours since overhaul.

BEA Delays Decision On Shortrange Jet

London—British European Airways has postponed its decision on purchase of a new shortrange jet airliner. Decision on the new aircraft was to have been made by July 29.

Question on whether the aircraft should have three or four engines is said to be the reason for the delay. Choice has been narrowed down to Bristol and de Havilland designs. Each has submitted three and four engine proposals.



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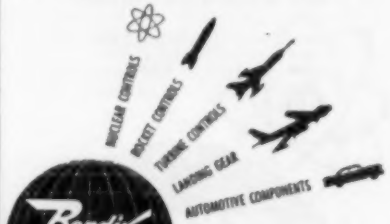

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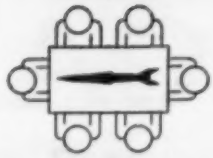

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Technical Personnel Dept. A-674

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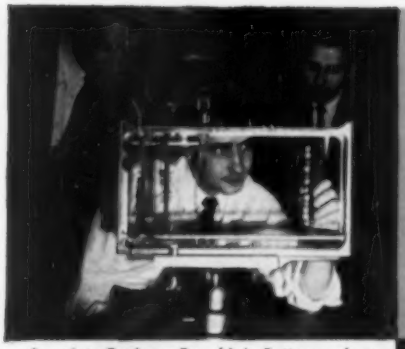

Associate Engineer Donald A. Patterson demonstrates a problem in pluggable unit layout.

Field Engineering Instructor Joseph Rechloff explains basic display console functions at IBM, Kingston, N. Y.

Associate Engineer Robert M. Blake points out a feature of an advanced magnetic tape circuit development.

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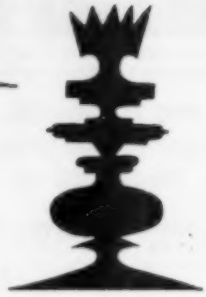

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11-8

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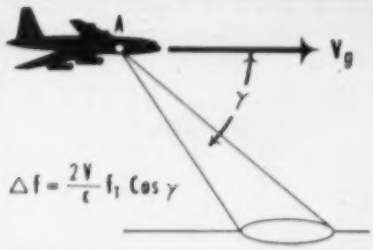

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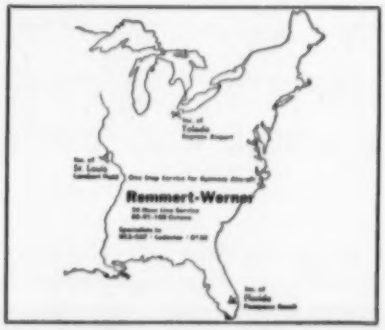

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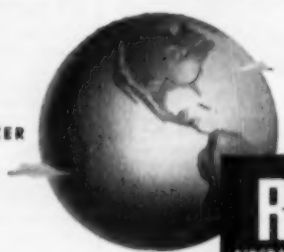
WORLD'S LARGEST PRODUCER  OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES

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ADVERTISERS IN THIS ISSUE

AVIATION WEEK, AUGUST 19, 1957

A. C. SPARK PLUG DIV., GENERAL MOTORS CORP. 139
Agency—D. P. Brother & Co.
AERO DESIGN & ENGINEERING COMPANY 136
Agency—Tom P. Gordon, Adv.
AEROTEC CORPORATION, THE 67
Agency—Hening and Company, Inc.
AIRCRAFT PRODUCTS COMPANY 72
Agency—Harris D. McKinney, Inc.
AIR FRANCE 63
Agency—Buchanan & Company, Inc.
AIR PRODUCTS INCORPORATED 98
Agency—The Aitkin-Kynett Co., Adv.
AIRWORK CORPORATION 152
Agency—Gene Wyble Advertising
ALLIS-CHALMERS MFG. CO. 17
Agency—Compton Adv., Inc.
ALLISON DIVISION, GENERAL MOTORS CORPORATION ..... Fourth Cover
Agency—Kudner Agency, Inc.
ALMAR-YORK CO., INC. 117
ALUMINUM TAPER MILLING CO., INC. 146
AMERICAN AIRLINES, INC. 42
Agency—Leuneu & Newell, Inc.
AMERICAN CABLE AND CHAIN, AUTOMOTIVE AND AIRCRAFT DIVISION 68
Agency—Reincke, Meyer, & Finn, Inc.
AMERICAN ELECTRONICS, INC. 90, 91
Agency—Dozier Eastman & Co.
AMERICAN MACHINE & FOUNDRY CO., DEFENSE PRODUCTS GROUP 60
Agency—Fletcher D. Richards, Inc.
AMERICAN WELDING & MFG. COMPANY, THE 66
Agency—The Bayless Kerr Co.
ARMA DIVISION, AMERICAN BOSCH ARMA CORP. 36
Agency—Doyle, Kitchen, & McCormick, Inc.
ARMCO STEEL CORPORATION 64
Agency—N. W. Ayer & Son, Inc.
AVIATION WEEK 131
AVRO AIRCRAFT LIMITED 92
Agency—Cockfield, Brown, & Co., Ltd.
BELL AIRCRAFT CORPORATION 11
Agency—Baldwin, Bowers, & Strachan, Inc.
BRUNSWICK-BALKE-COLLENDER COMPANY 62
Agency—McCann Erickson, Inc.
BUCKEYE IRON & BRASS WORKS, INC., THE 100
Agency—Kircher, Helton & Collett, Inc.
BURROUGHS CORPORATION 118
Agency—Campbell Ewald Company
CARGO TRANSPORT LEASING CORP. 111
Agency—Ritter, Sanford & Price, Inc.
CESSNA AIRCRAFT COMPANY 134
Agency—Lago & Whitehead, Inc.
CHAMPION SPARK PLUG COMPANY 83, 84, 85, 86
Agency—J. Walter Thompson Company
CONNECTICUT HARD RUBBER COMPANY 145
Agency—Troland, Inc. Adv.
CONSOLIDATED ELECTRODYNAMICS CORPORATION 15
Agency—Hixson & Jorgensen, Inc.
CONTINENTAL MOTORS CORPORATION 103
Agency—The Hopkins Agency
CONVAIR A DIVISION OF GENERAL DYNAMICS CORPORATION 139
Agency—Hixson & Jorgensen, Inc.
CURTISS WRIGHT CORPORATION 122, 123
Agency—Burke Dowling Adams, Inc.
DARNELL CORPORATION, LTD. 132
Agency—Rhea Advertising
DAVIES LABORATORIES, DIVISION MINNEAPOLIS-HONEYWELL 80
Agency—The Harry P. Bridge Company
DIECRAFT, INC. 80
Agency—The Ogden & Strouse Co.
DOUGLAS AIRCRAFT COMPANY, INC. 96, 97
Agency—J. Walter Thompson Company
DOW CHEMICAL COMPANY 20
Agency—MacManus, John & Adams, Inc.
ECKEL VALVE COMPANY 107
Agency—Budler Advertising
ECLIPSE-PIONEER DIVISION—BENDIX AVIATION CORPORATION 74
Agency—MacManus, John & Adams, Inc.
EXECUTIVE AIRCRAFT SERVICE INC. 80
Agency—Auid Advertising
FAFNIR BEARING COMPANY, THE 70
Agency—Noyes Company, Inc.
FAIRCHILD ENGINE & AIRPLANE CORPORATION 24
Agency—Garner, Culman, Pegelis, & Varley, Inc.
FENWAL INC. AVIATION PRODUCTS DIV. 22
Agency—James Citrin Company
FLIGHT REFUELING, INC. 127
Agency—Davis, Parsons & Strohmeier Inc.
FORD INSTRUMENT COMPANY, DIV. SPERRY RAND CORP. 115
Agency—G. M. Basford Company
GENERAL CONTROLS, AIRCRAFT CONTROLS DIVISION 14
Agency—Hixson & Jorgensen, Inc.
GENERAL ELECTRIC COMPANY 78, 79
Agency—G. M. Basford Company
GENERAL LABORATORY ASSOCIATES, INC. 5
Agency—The Fred Riger Adv. Agency
GENERAL MILLS, INC. 88
Agency—Knox Reeves Advertising, Inc.
GOODYEAR AIRCRAFT CORPORATION 3
Agency—Kudner Agency, Inc.
HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION 9
Agency—D. P. Brother & Company, Adv.
HARVEY ALUMINUM DIVISION OF HARVEY MACHINE COMPANY, INC. ..... Third Cover
Agency—Hixson & Jorgensen, Inc.
HI SHEAR RIVET TOOL COMPANY 55
HOFFMAN ELECTRONICS CORPORATION 118, 119
Agency—Dan B. Miner Company, Inc.
HYATT BEARINGS DIVISION, GENERAL MOTORS CORPORATION 10
Agency—D. P. Brother & Company
JACK & HEINTZ, INC. 17
Agency—Fuller & Smith & Ross, Inc.
KAYNOR COMPANY, THE KAYLOCK DIVISION ..... Second Cover
Agency—J. M. Straus & Company
LAVELLE AIRCRAFT CORPORATION 69
Agency—The Roland G. E. Ullman Org.
LEONARD, INC., WALLACE O. 82
Agency—West Marquis, Inc.
LIVERMONT, INC. 142
Agency—Welsh & Hollander Adv.
LOCKHEED AIRCRAFT CORPORATION 139
Agency—Hal Hoskins Adv.
LORD MFG. COMPANY 133
Agency—The Jayme Organization, Inc.
LOS ANGELES DIV. NORTH AMERICAN AVIATION, INC. 140
Agency—Batten, Barton, Durstine & Osborn, Inc.
MARQUARDT AIRCRAFT COMPANY 144
Agency—Grant Adv. Agency
MAXSON CORPORATION, THE W. L. 101
Agency—Engineered Advertising
NARMCO RESINS & COATINGS COMPANY 8
Agency—Riley Nelson Company
NATIONAL AERONAUTICAL CORPORATION 99
Agency—Davis, Parsons, & Strohmeier, Inc.
NETWORKS ELECTRONICS CORPORATION 147
Agency—The McCarty Company
NEW HAMPSHIRE BALL BEARINGS, INC. 57
Agency—Shattuck, Clifford & McMillan, Inc.
NEW YORK AIRBRAKE COMPANY, THE—WATERTOWN DIVISION 18
Agency—Humbert & Jones, Inc.
NORTHROP AIRCRAFT, INC. 35
Agency—West Marquis Inc.
OSTER MFG. COMPANY, JOHN—AVIONIC DIVISION 110
Agency—Burton Browne Adv.
PACIFIC AUTOMATION PRODUCTS, INC. 16
Agency—Mann Adv. Agency, Inc.
PACIFIC DIVISION—BENDIX AVIATION CORPORATION 108
Agency—The Shaw Company Adv.
PIONEER CENTRAL DIVISION OF BENDIX AVIATION CORPORATION 125
Agency—MacManus, John & Adams, Inc.
REACTION MOTORS, INC. 120, 121
Agency—The Aitkin-Kynett Co.
REEVES INSTRUMENT CORPORATION 126
Agency—The Edward W. Robotham Company
REPUBLIC STEEL CORPORATION 104, 105
Agency—Meldrum & Fewsmith, Inc.
ROCKBESTOS PRODUCTS CORPORATION 4
Agency—Sutherland Abbott Adv.
ROHM & HAAS COMPANY 124
Agency—Arndt-Preston-Chapin-Lamb & Keen, Inc.
ROHR AIRCRAFT CORPORATION 164
Agency—Barnes Chase Company
ROLLS-ROYCE LTD. 46
Agency—The Wesley Associates Adv.
RYAN AERONAUTICAL COMPANY 141
Agency—Batten, Barton, Durstine & osborn, Inc.
SCINTILLA DIVISION—BENDIX AVIATION CORPORATION 102
Agency—MacManus, John & Adams, Inc.
SEARCHLIGHT SECTION 152-163
SHORT BROTHERS & HARLAND LTD 141
SIMMONDS AEROCESSORIES, INC. 54
Agency—Burke Dowling Adams, Inc.
SINCLAIR REFINING COMPANY 44
Agency—Mercy, Humm & Warwick, Inc.
SNOW CO., W. H. 99
Agency—McKee, Burns Advertising
SOLAR AIRCRAFT COMPANY 93
Agency—The Phillips-Ramsey Company, Inc.
SOLARTRON, INC. 36
Lionel & Tierney, Inc.
SPERRY GYROSCOPE COMPANY—DIV. OF SPERRY RAND CORPORATION 58
Agency—Reach, Yates & Mattoon, Inc.
STANDARD PRESSED STEEL COMPANY 100
Agency—Gray & Rogers Adv.
TEXCO AIRCRAFT CORPORATION 7
Agency—McCann Erickson Inc.
THERM-ELECTRIC METERS COMPANY, INC. 165
Agency—Taylor M. Ward, Inc.
TOWNSEND COMPANY CHERRY RIVET DIV. 6
Agency—Bond & Starr, Inc.
TUBE METHODS, INC. 75
Agency—John Miller Adv., Agency
TURCO PRODUCTS, INC., CHEM.-MILL DIV. 52
Agency—Van Der Boom, Hunt, McNaughton, Inc.
UNITED AIRCRAFT PRODUCTS, INC. 148
Agency—Weber, Geiger, & Kalat, Inc.
VICKERS, INC. DIVISION OF SPERRY RAND CORPORATION 138
Agency—Witte & Burden Adv.
VICKERS-ARMSTRONG LTD. 48, 49
Agency—McCann Erickson Inc.
WEATHERHEAD COMPANY, THE AVIATION DIV. 94
Agency—Chamberlin-Junk Adv., Inc.
WEBER AIRCRAFT CORPORATION 145
Agency—Byron H. Brown & Staff, Inc.
WESTERN GEAR CORPORATION 13
Agency—Ruthraff & Ryan, Inc.
WESTINGHOUSE ELECTRIC CORPORATION 112, 113
Agency—Fuller & Smith & Ross, Inc.
WINDCHARGER CORPORATION 106
Agency—W. D' Leon Company, Inc.

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 153-162
EQUIPMENT (New)
For Sale 163

ADVERTISERS INDEX

AC The Electronics Div., General Motors Corp. 155, 161
Air World Manufacturing 163
Allied Research Associates 160
Arma, Div., American Bosch Arma Corp. 158
Austin Sales Co. 162
Cessna Aircraft (Pawnee) 159
Collins Engineering Co. 163
Engine Works 163
Flying Tiger Line 162
General Electric Co.
Aircraft Nuclear Propulsion Dept. 153
Heavy Military Electronic Equipment 156
Jet Engine Dept. 161
General Precision Laboratory 163
International Business Machines Corp. 159
Lund Aviation Ltd. 163
Lycoming Div., Avco Manufacturing Co. 162
McDonnell Aircraft Corp. 154
Navco 163
Pasoero Engineering Corp. 163
Products Div., Bendix Aviation Corp. 156
Radio Corp of America 158
Remington Rand Univac 157
Rommert-Werner Inc. 153
Swordrop & Parcel Inc. 162
System Development Div., Rand Corp. 160
Systems Div., Bendix Aviation Corp. 154
Trade-Aver Co. 163
Volitan Aviation Inc. 163

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LETTERS

AGARD Interest

AGARD was extremely interested in an article which appeared on p. 325 of the June 3 issue of AVIATION WEEK.

A member of our staff is about to visit Turkey, Greece and Portugal and would like to have copies of this article for distribution. Would it be possible for us to have 225 reprints?

ELIZABETH CONNELLY
Publications Editor
Advisory Group for Aeronautical
Research and Development

Others to Salute

I have read, with a great deal of interest and some curiosity, your editorial, "Salute to the Sabre," in the July 15 issue of AVIATION WEEK.

My interest, of course, was in the subject of the editorial, the F-86 Sabre jet, which has proven to be a fine airplane. As pointed out in the latter half of your editorial, the F-86 does deserve a niche for itself in aviation history along with other "firsts."

My curiosity stems from the first half of the editorial where the "salute" seems to be to North American Aviation rather than to the F-86. In the second paragraph, the P-51 Mustang was selected to represent World War II. No mention was made of the P-38 Lightning which fought Japanese for some months before the P-51 showed up. No mention was made of the "shelf" carved out by the B-17, and I flew the P-47 Thunderbolt against the Germans when they were at their peak for eight to ten months in 1943 before any Mustangs arrived in that Theater. It was only after the P-47s pushed the Luftwaffe beyond P-47 range that the P-38s and the P-51 Mustangs entered the area.

P-47 Thunderbolts destroyed or damaged more than 11,000 of the Luftwaffe's fighting machines and even after the P-38s and P-51s were brought in the Thunderbolt continued to do a terrific job of bomber escort and, at the same time, opened the door on the ground so that Patton's Army broke speed records in its run toward Berlin. Against ground targets the Thunderbolt is credited with destroying or damaging 9,000 locomotives, 160,000 other Axis units of rail and motorized equipment, and countless other enemy implements of war.

In the Korean War, the F-86 should have its niche right along side of the F-80 and the F-84. The old F-80 dealt misery and destruction to the Commies from the beginning and well into the closing of the Korean War. The F-84 Thunderjet with its long range and high load carrying capabilities hamstrung the Commies with a choking interdiction program, accounting for 23,000 enemy casualties, 200,000 buildings, 4,200 locomotives and rail cars, 10,000 rail "cuts" and a vast variety of tanks, trucks, tunnels, bunkers and supply dumps. Mention is rarely made of the 130 MiG fighters destroyed or damaged by Thunderjets, although the aircraft's mission was to attack enemy communications and supply lines. The F-84 probably inflicted more total damage to the enemy than any other single element in the war.

In the "cold war," from the end of World War II to the present, F-80s, F-84s, F-89s, F-94s and other fighter aircraft have distinguished themselves along with F-86s. In that period F-84 Thunderjets won eight major aviation awards, set two non-stop jet fighter distance records and made the first non-stop transatlantic jet flight. F-84 Thunderstreaks set a world's nonstop jet fighter distance record and the official U.S. transcontinental speed record—a record which stood for more than two years and was broken only last month by Chance Vought's Crusader. All of the F-84s—Thunderjet, Thunderstreak and Thunderflash—are still very active, flying with the U. S. Air Force and the air forces of 14 mutual defense and NATO countries. A tally of American aviation during these years would turn up similar records for other well-designed, well-built aircraft.

In short, I felt the editorial was too brief to cover such an outstanding company as North American Aviation, and none too exclusive as a "Salute to the Sabre."

R. S. JOHNSON
Woodbury, N. Y.

(Col. Robert S. Johnson was USAF's 4th ranking ace in air-to-air combat in World War II with 28 air-to-air victories, while flying a Republic P-47 Thunderbolt in the European Theater of Operations. He is now projects administrator at Republic Aviation Corp.—Ed.)

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address Letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

That P2V Again

Regarding Mr. Lewis' letter in the July 8 AVIATION WEEK, regarding the "Neptune" on p. 33 of the June 17 issue I believe the correct designation is PB4Y-2, not PB2Y-4 as stated and verified. Could it be that both Pilot Lewis and AVIATION WEEK are guilty of that "pretty juvenile mistake"? If my before high school memory serves me correctly the PB2Y was a four engined patrol seaplane.

LTJG B. N. MILLER, USN
Utility Squadron Four
Chincoteague, Va.

Ranger Builder

Referring to the picture of the "Ranger," p. 61 of your July 15 issue, it shows the vessel under construction at the piers of her builders, The Newport News Shipbuilding and Dry Dock Company, Newport News, Va., and not at the Norfolk Naval Shipyard as stated. All construction plans for every class of U. S. Naval aircraft carrier that the U. S. Navy has had to date, with the exception of conversions, the "Wasp," and some of the small escort vessels, were made by and at least the first vessel of each class built by Newport News. This includes, for example, the old Ranger, Yorktown, Essex, Midway and Forrestal classes. The new Ranger is the third vessel of the Forrestal class, the latter also being a Newport News product. Both naval and other private shipyards have built following sister ships from duplicated plans.

Let's not give our good friends in the Norfolk Naval Shipyard credit for something that they did not do. The Ranger is having her trial trips this month (July) and is scheduled to be delivered soon to the Navy at the Naval Shipyard, Norfolk, Va., for commissioning into active service.

S. A. VINCENT
Consulting Naval Architect
Newport News Shipbuilding and
Dry Dock Co.
Newport News, Va.

(AVIATION WEEK, *as well as the Associated Press and the New York Times, were led astray on the Ranger picture because it was miscaptioned by the Department of Defense when it was issued.—Ed.*)

Italian Coverage

In behalf of the Centro Aeronautico & Atomico Italiano, I wish to compliment AVIATION WEEK and Dave Anderton for the excellent coverage given to Italian aeronautical activities—namely the Aerfer Sagittario (AW May 13, p. 60) and Fiat G.91 (AW June 10, p. 50) and the cover picture of the Sabre Italian acrobatic team (AW June 17).

Our CAAI is particularly grateful to AVIATION WEEK for its Italian coverage, inasmuch as the dissemination of information on our aircraft and industrial possibilities helps us in our purpose of promoting the closest cooperation between the Italian and the American aircraft industries.

LT. COL. DR. ING. FRANCO FIORIO
Centro Aeronautico & Atomico Italiano
Italian Aeronautical & Nucleonic Center
Arlington, Va.

Army Man's View

I'm disgusted with your cry-baby editorials and have so notified my congressman, Senator Russell and Representative Vinson of Georgia.

It appears that you expect Uncle Sugar to keep your aircraft industries going—regardless of the military needs or consideration of the poor taxpayer. Typical non-Christian attitude!

I intend to continue to bring this situation before Congress and the public. As a soldier my country comes first—my pocketbook is secondary. This point of view I realize you cannot understand. Also, your continued publication of security matters is a bit shocking.

COL. T. A. McCRARY
Material Requirements Team
Joint Logistic Plans Group
U. S. Army Element
Office, Joint Chiefs of Staff
Washington, D. C.

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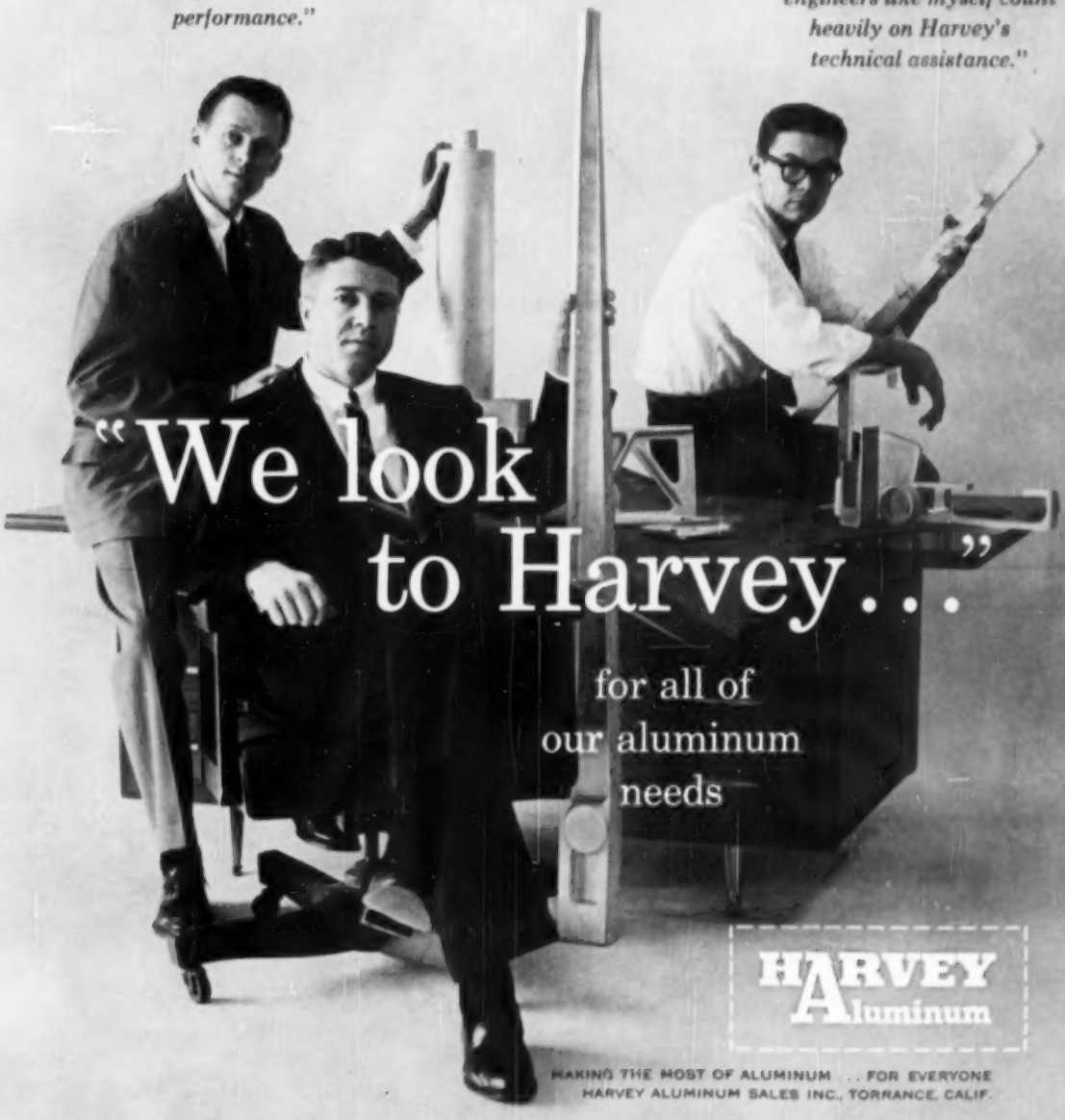

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